A novel paradigm for the exploitation of multitemporal satellite optical imagery

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Earth Observation Center (EOC)
German Remote Sensing Data Center (DFD)
Land Surface (LAX)

Motivation

- Optical satellite imagery: key support to agriculture, forestry, risk management, disaster monitoring and natural resource management.






Motivation

- Availability of satellite optical data has been lately growing as never before (Big Data Era);
- Need for efficient and practical methodologies;
- State-of-the-Art: most techniques still rely on single-date acquisitions:
  - specific conditions (e.g., smaller sun elevation in winter);
  - lack of key information (e.g., different land-cover classes have same characteristics in certain periods of the year);
  - **cloud coverage**.

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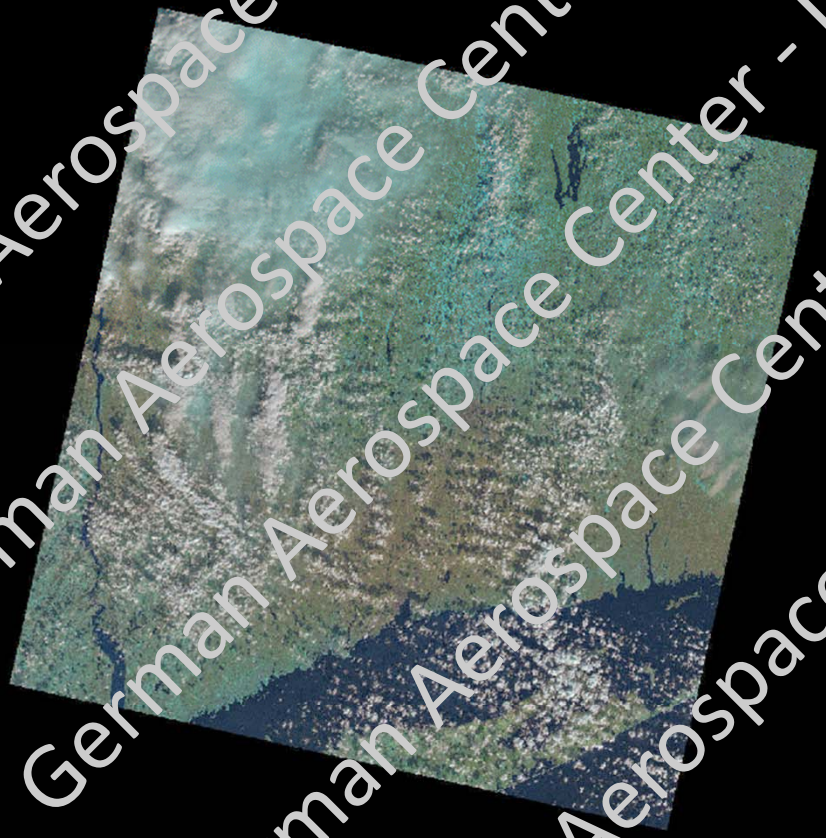
  - **cloud coverage**.

- **TEMPORAL SERIES** – how to exploit all the available information?
- New method applied to **Landsat-5/7/8** imagery from 1984 to present.

New York

2015 Landsat-8 OLI

cloud cover < 60%

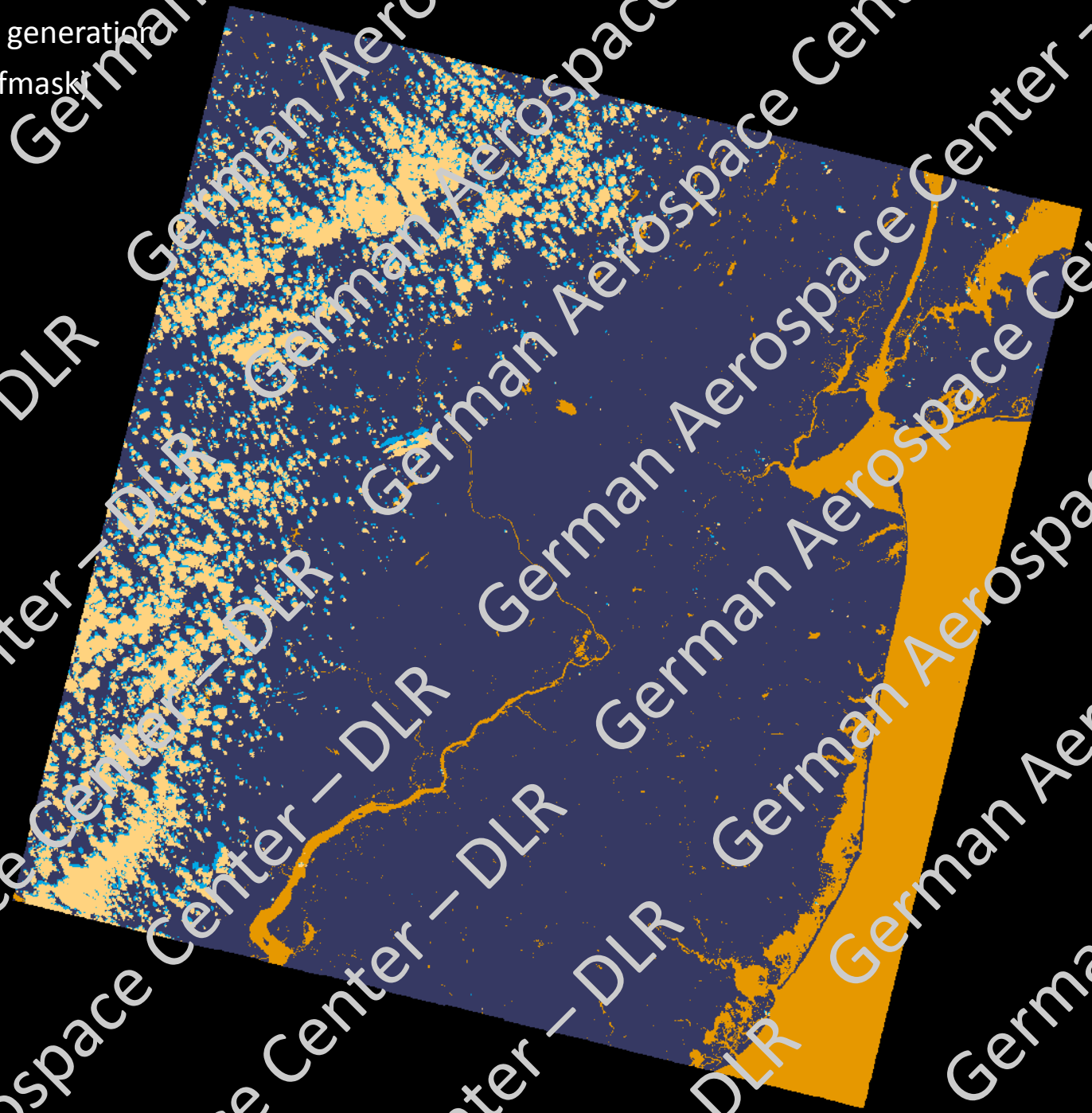


mosaic of scenes with less cloud coverage per path/row combination

L1 calibration

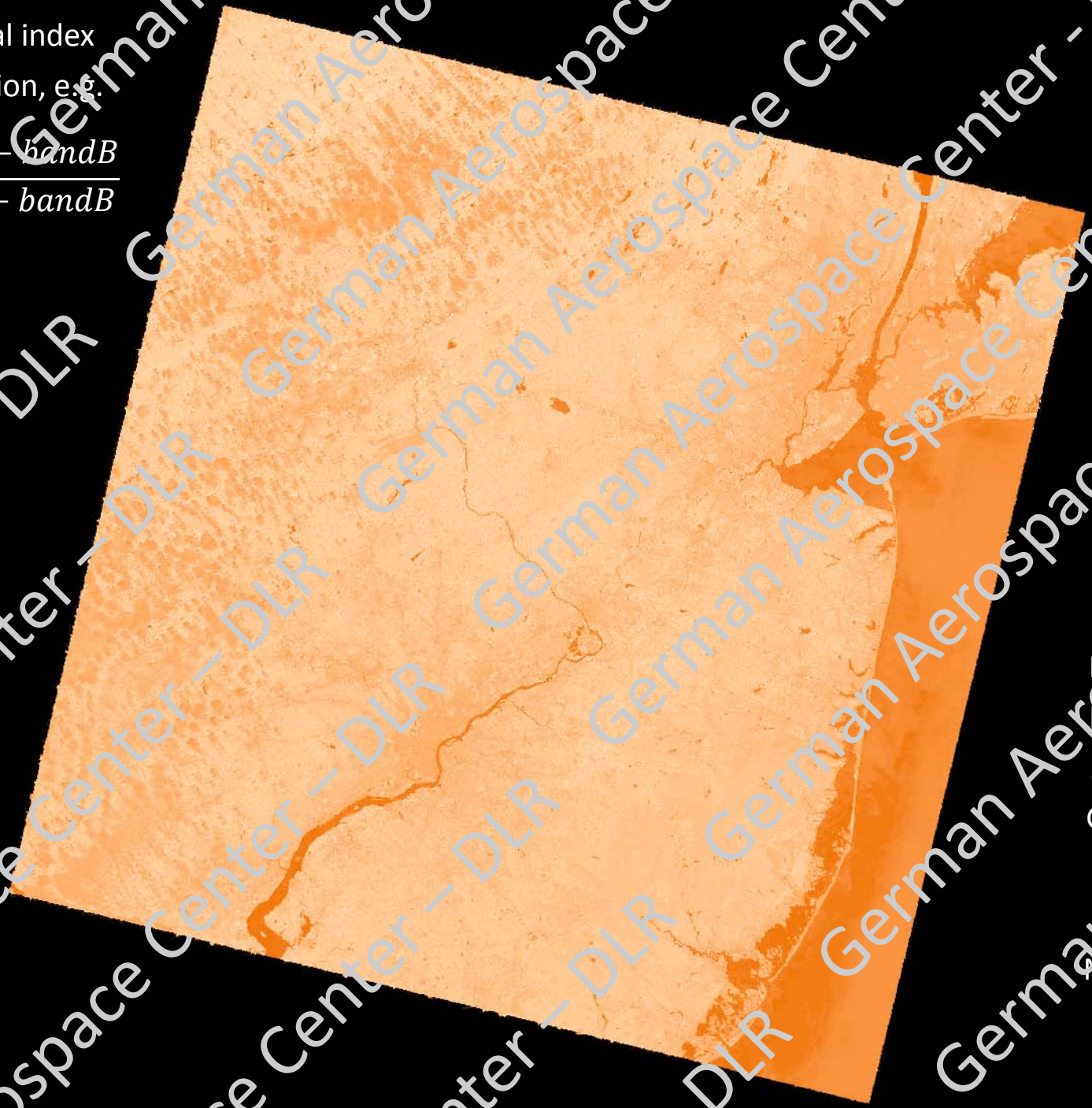
(+ atmospheric correction)

2. cloud mask generation
(fmask/cfmask)



3. spectral index computation, e.g.

$$\frac{bandA - bandB}{bandB + bandB}$$

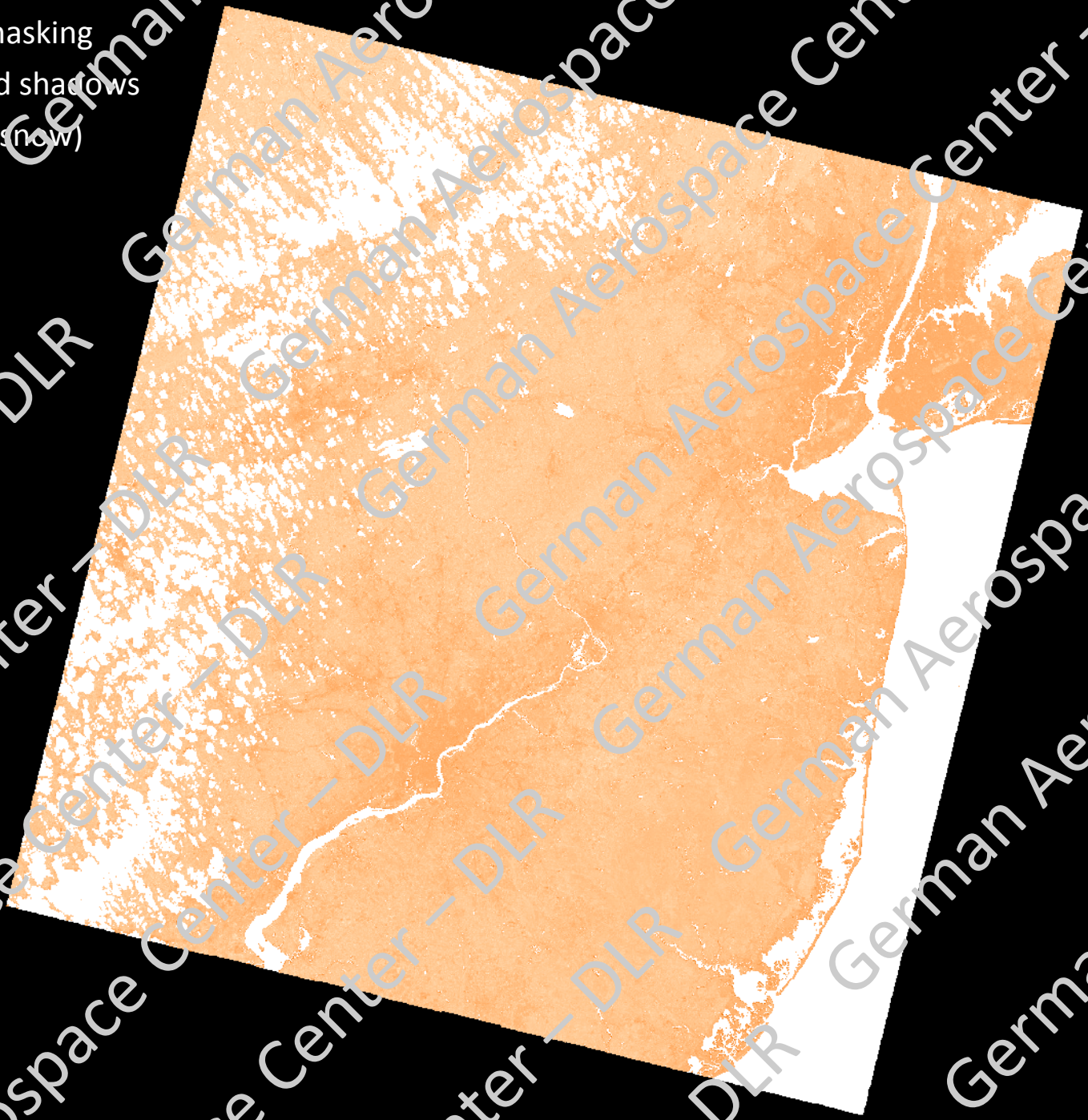


NDVI
NDBI
ARVI
GEMI
SAVI
EVI
NDWI
...

4. cloud masking

clouds + cloud shadows

(+ water, snow)



- **overall** for each pixel there is anyhow a consistent number of cloud-free observations

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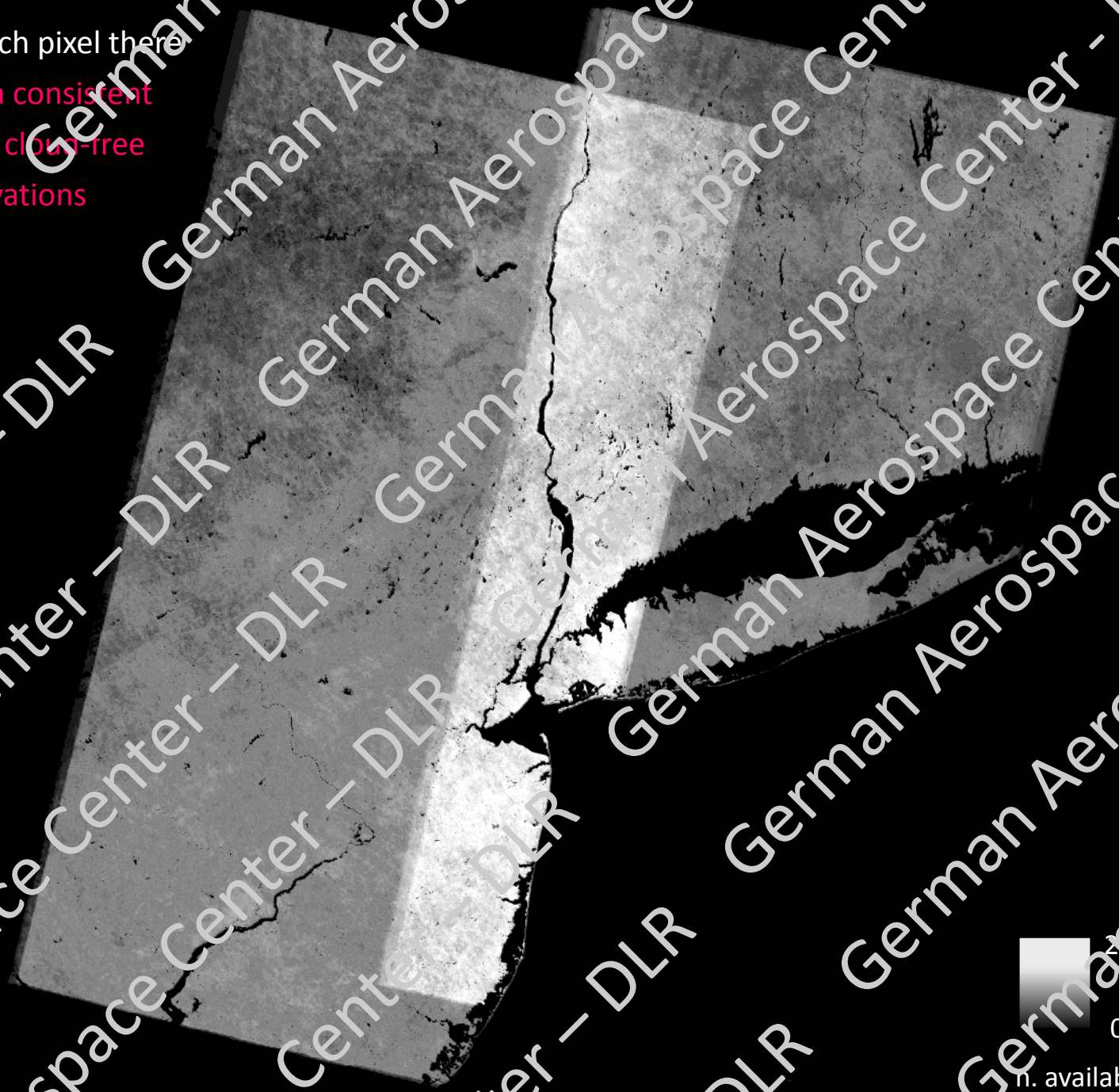

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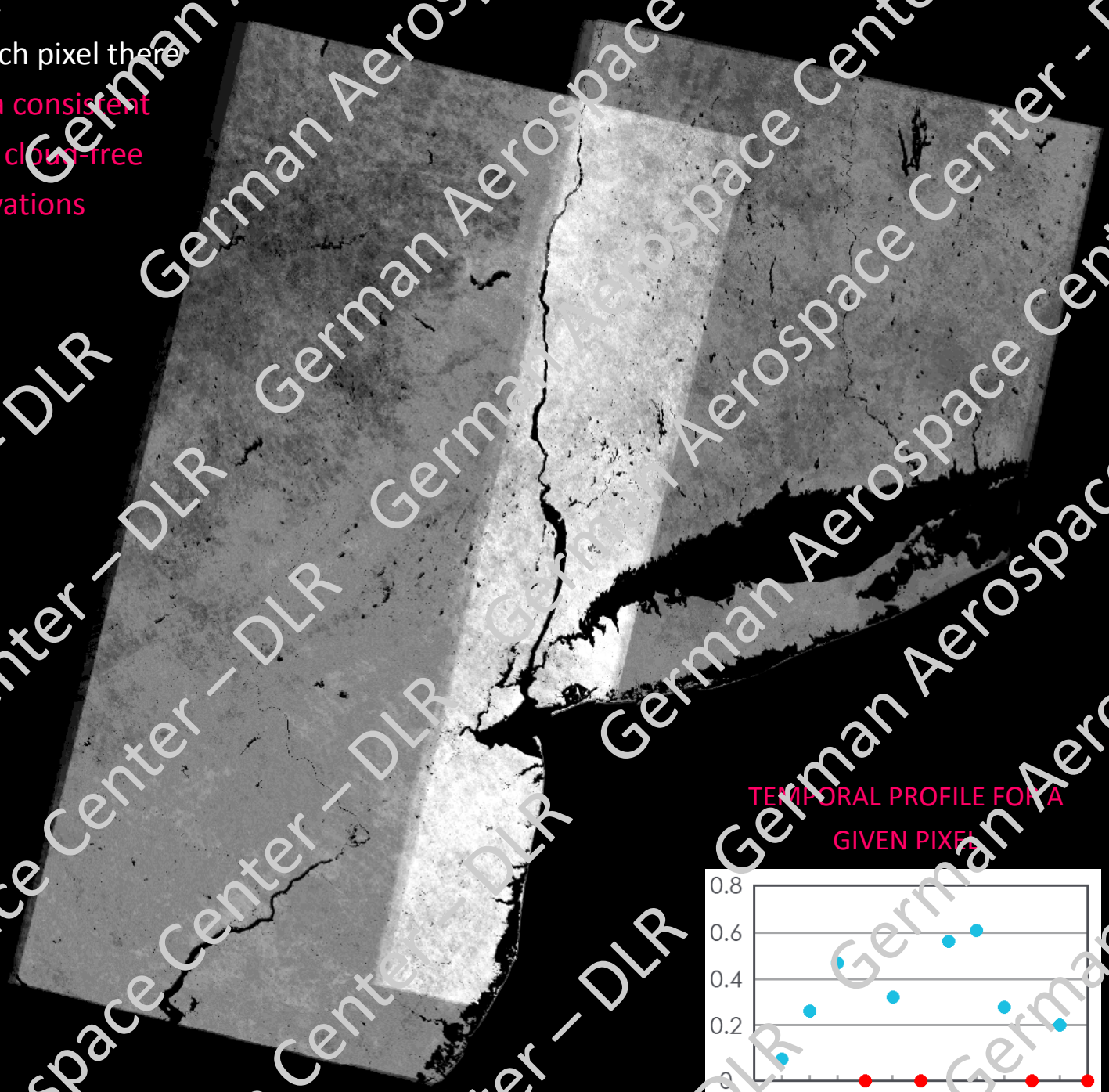


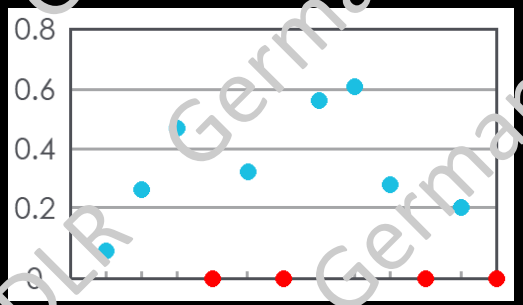
TEMPORAL PROFILE FOR A GIVEN PIXEL

5. extraction of key

TEMPORAL STATISTICS

for each pixel

TEMPORAL PROFILE FOR A GIVEN PIXEL



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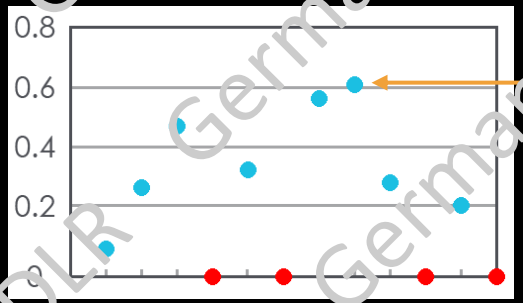
TEMPORAL STATISTICS

for each pixel



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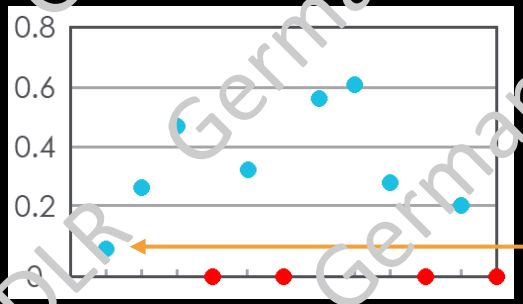

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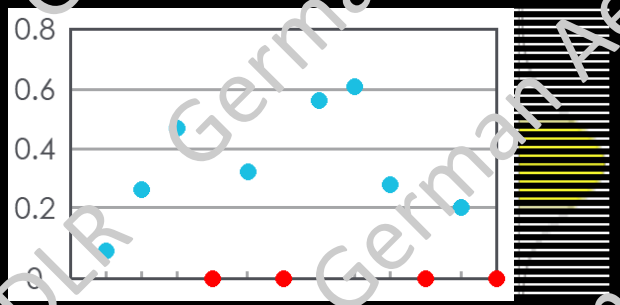

6. repeat the procedure for all spectral indexes useful for the specific investigated application

NDBI

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ARVI

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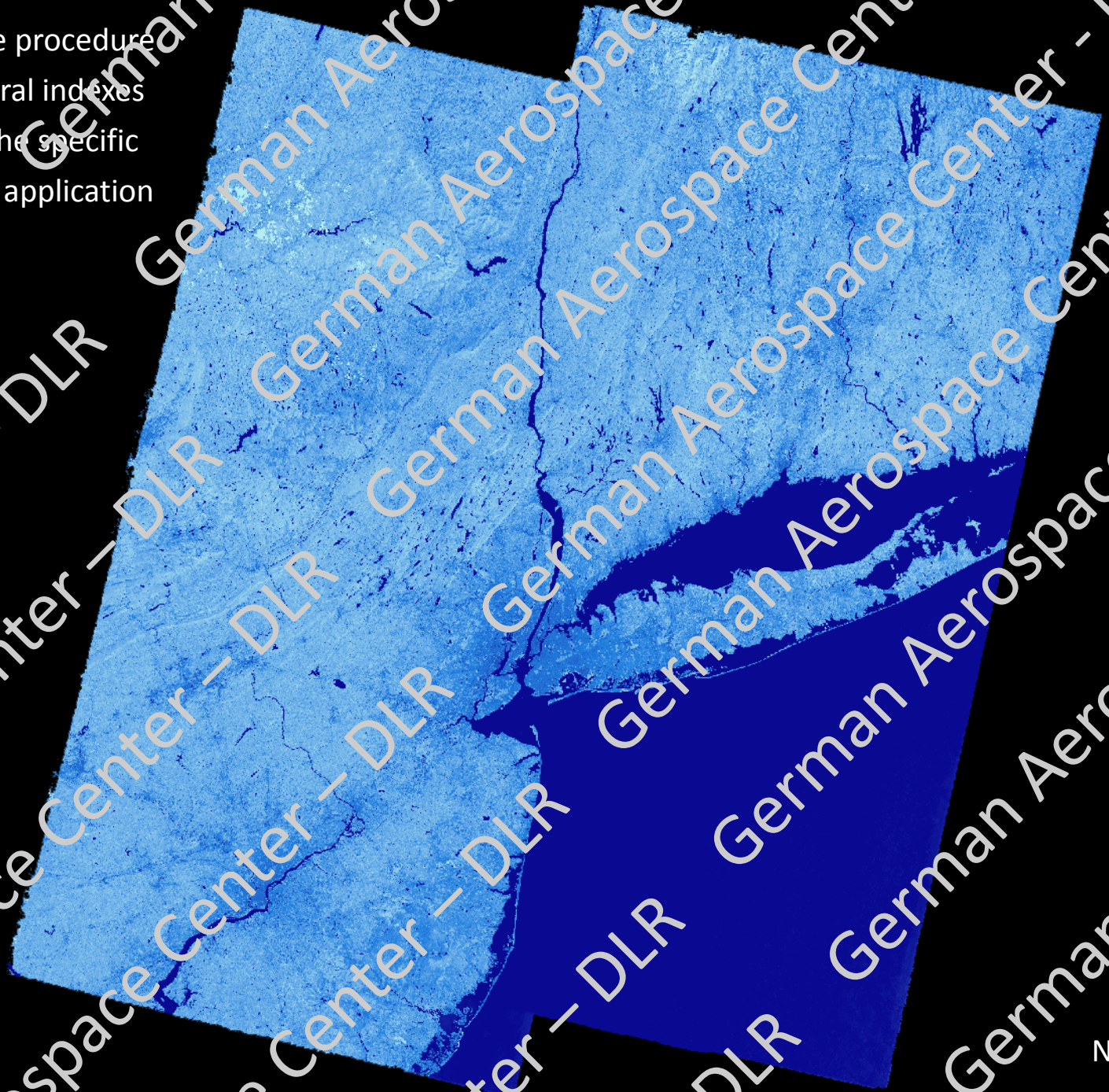
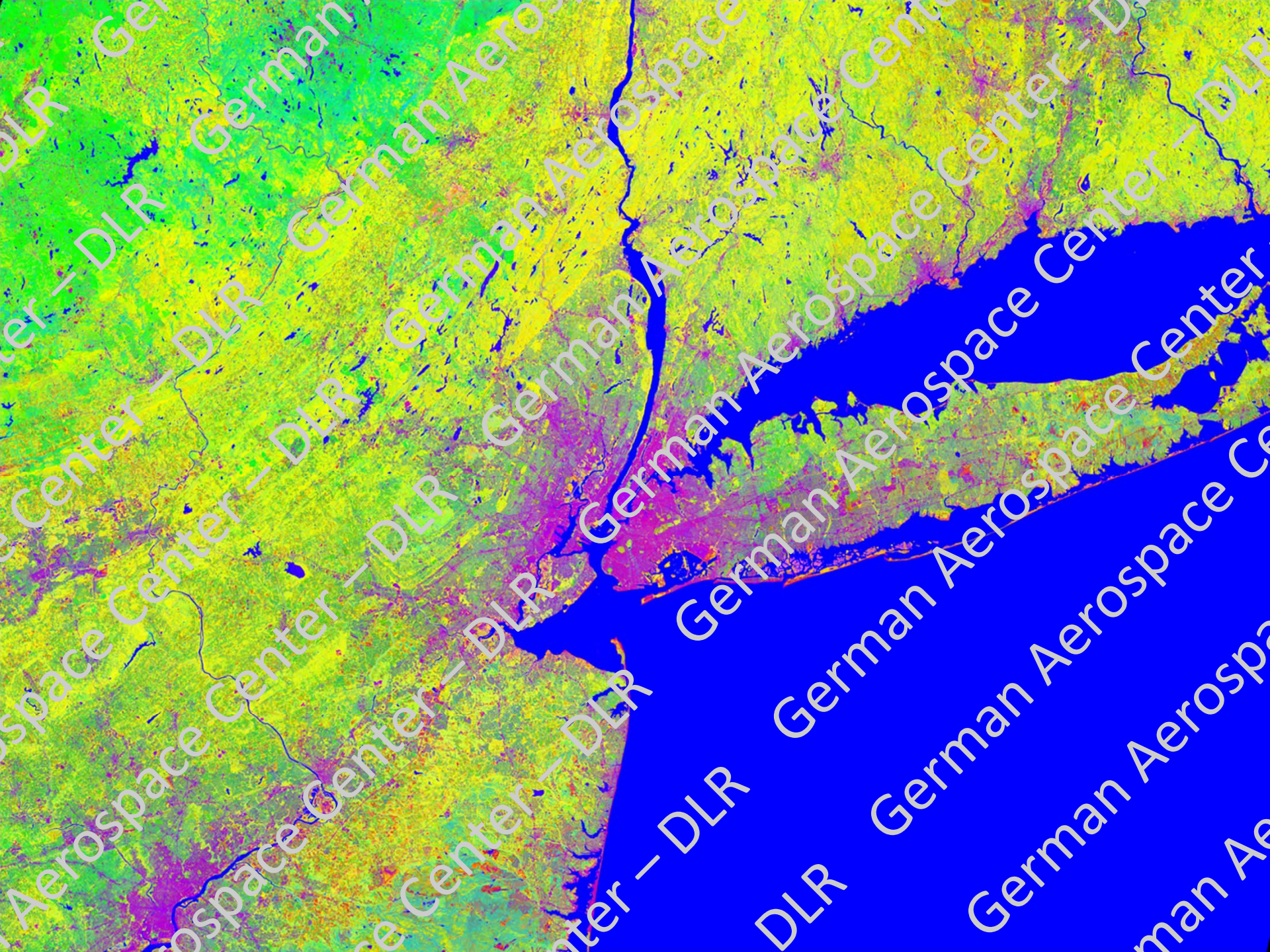
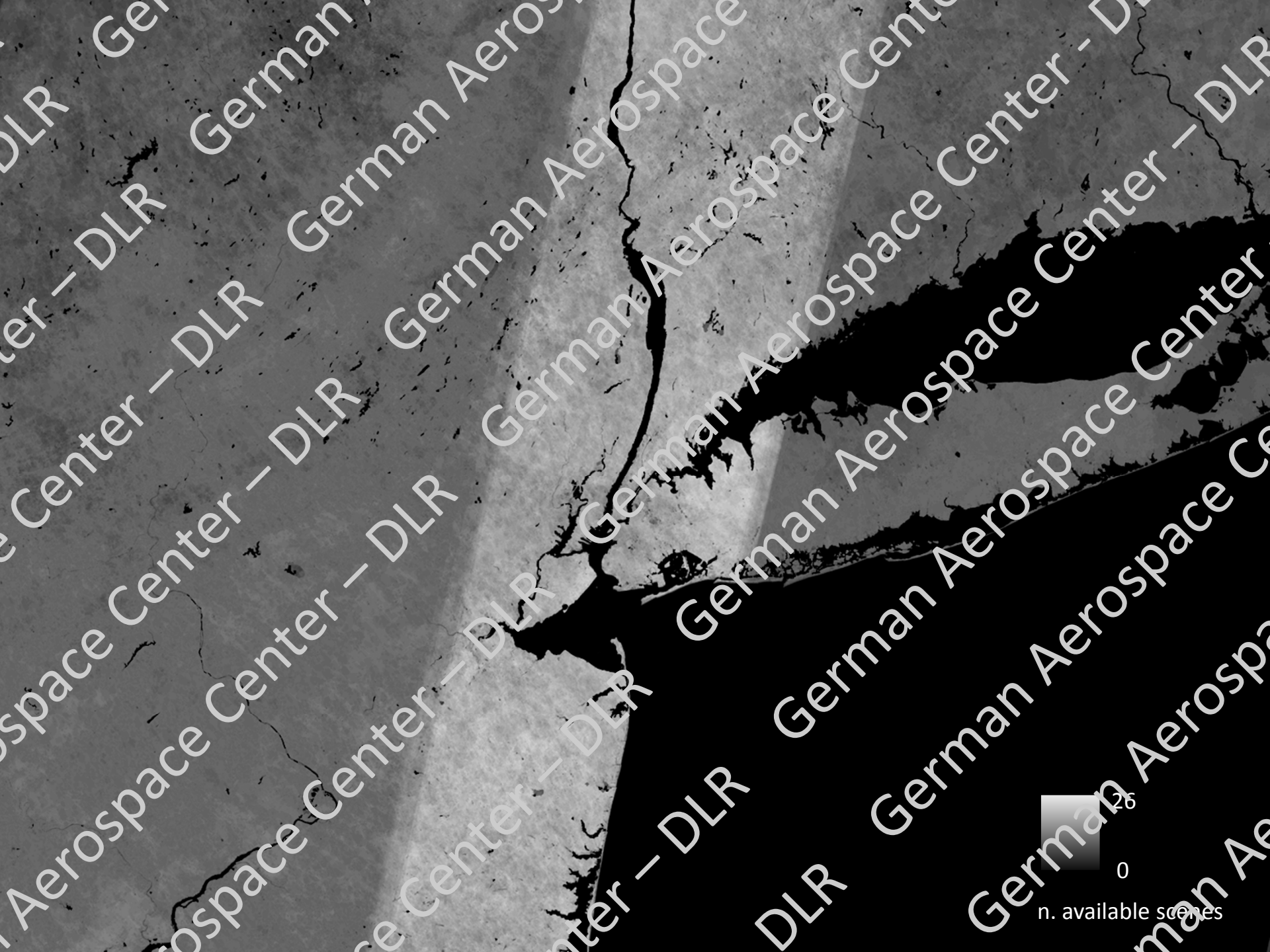
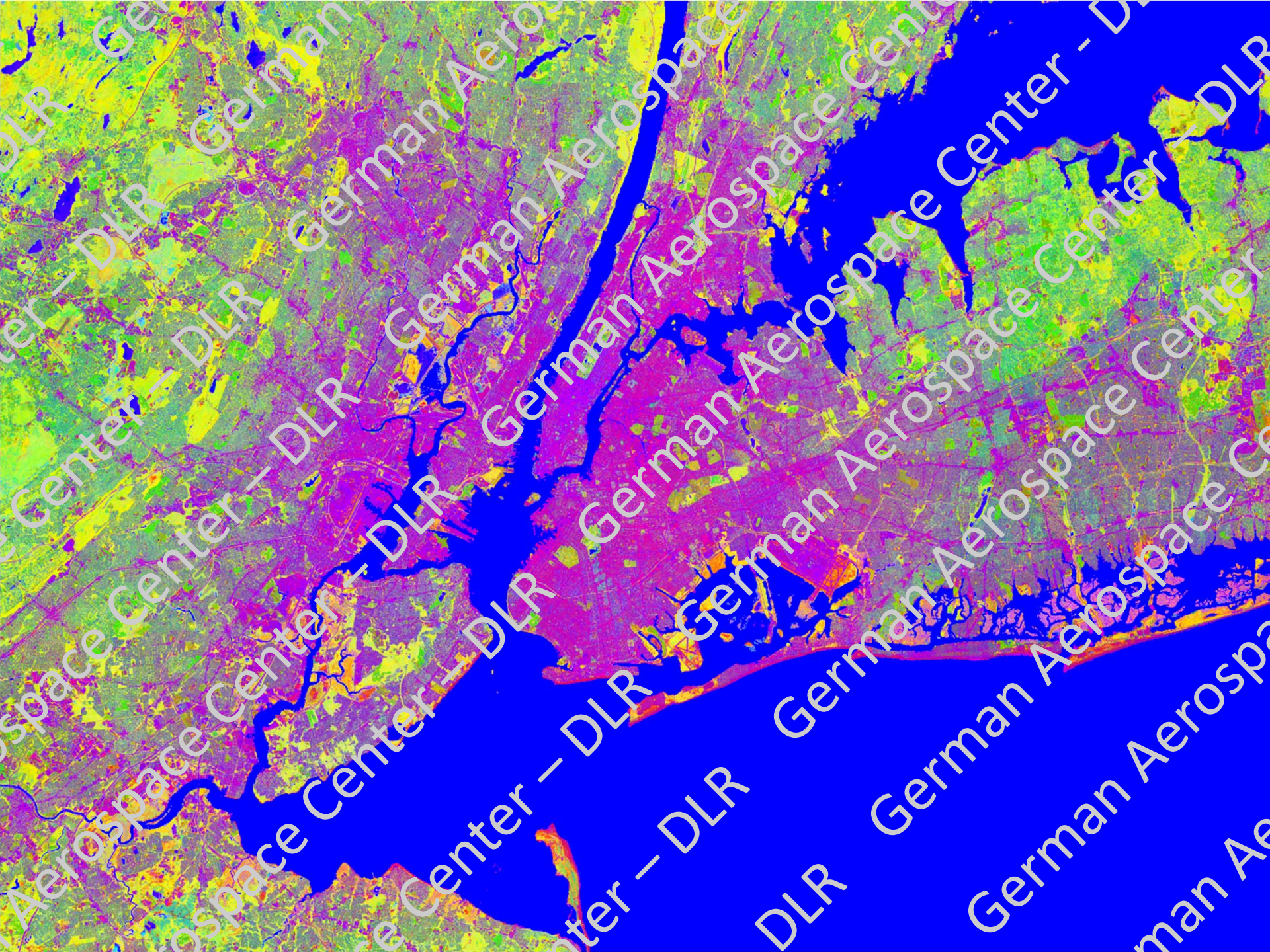


NDWI

7 combine!


German Aerospace Center – DLR


26
0
n. available scenes


German Aerospace Center – DLR


26
0
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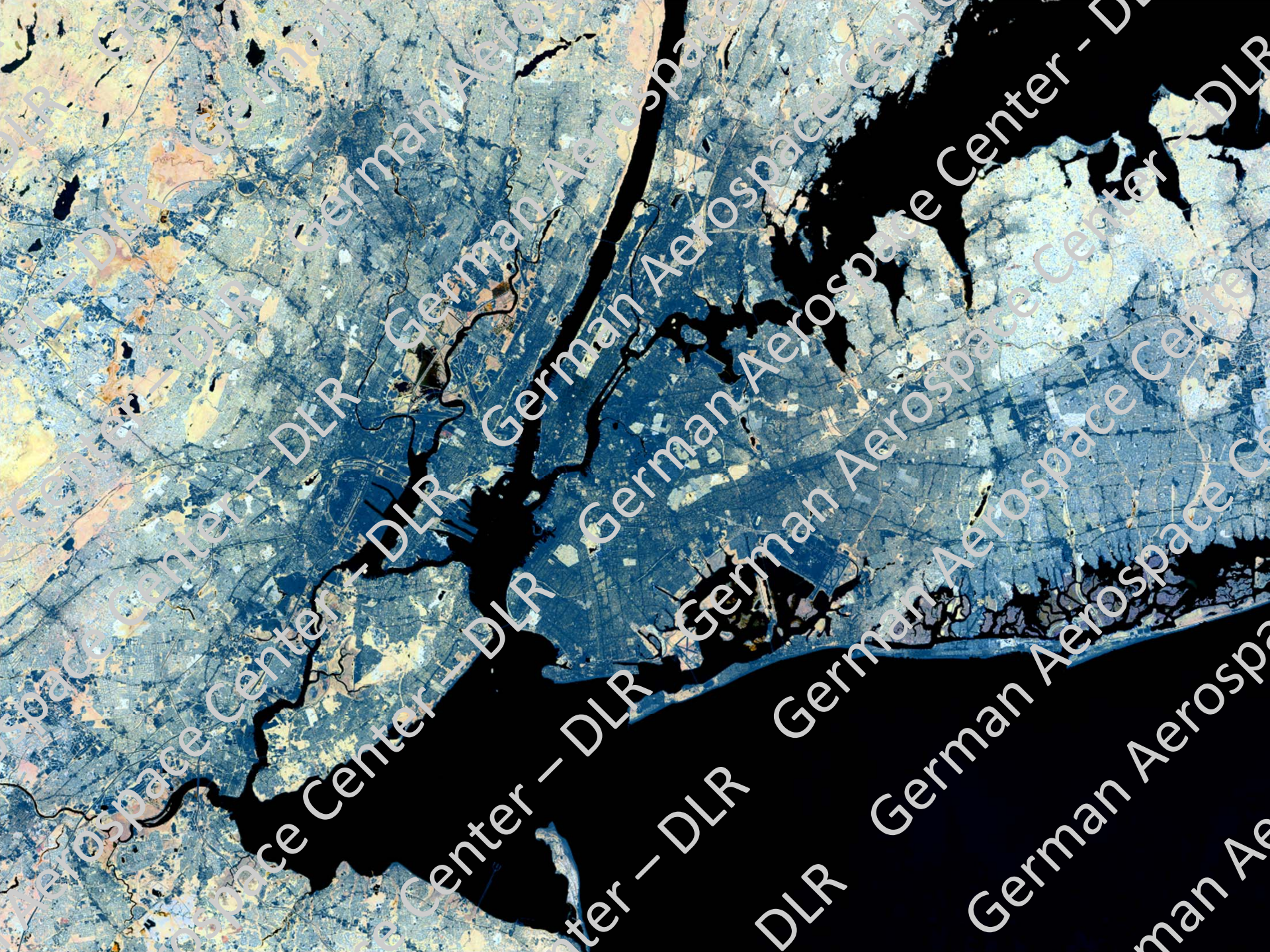

German Aerospace Center – DLR

Main Advantages

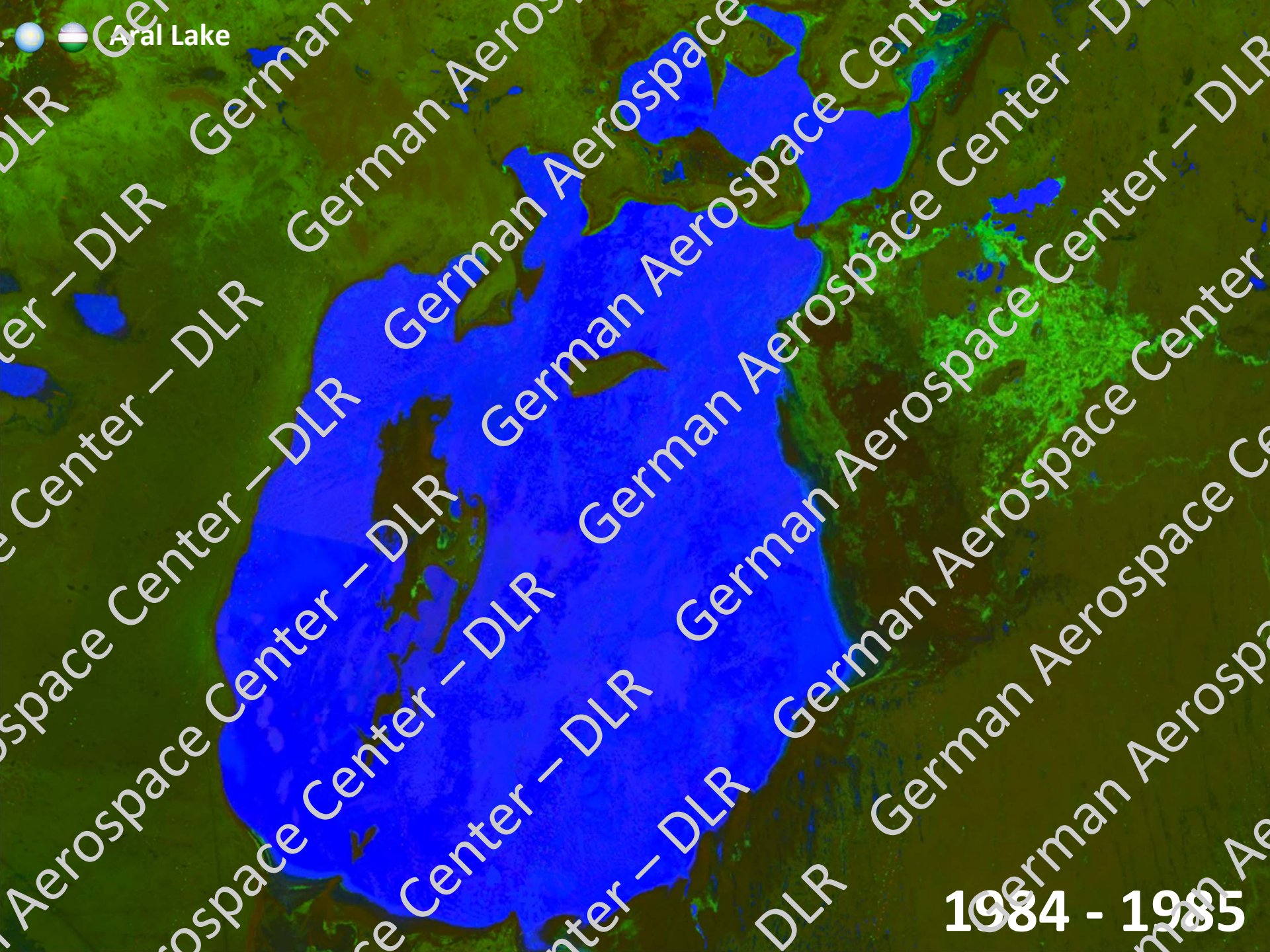
Accounts for **all available information** over time per each pixel.

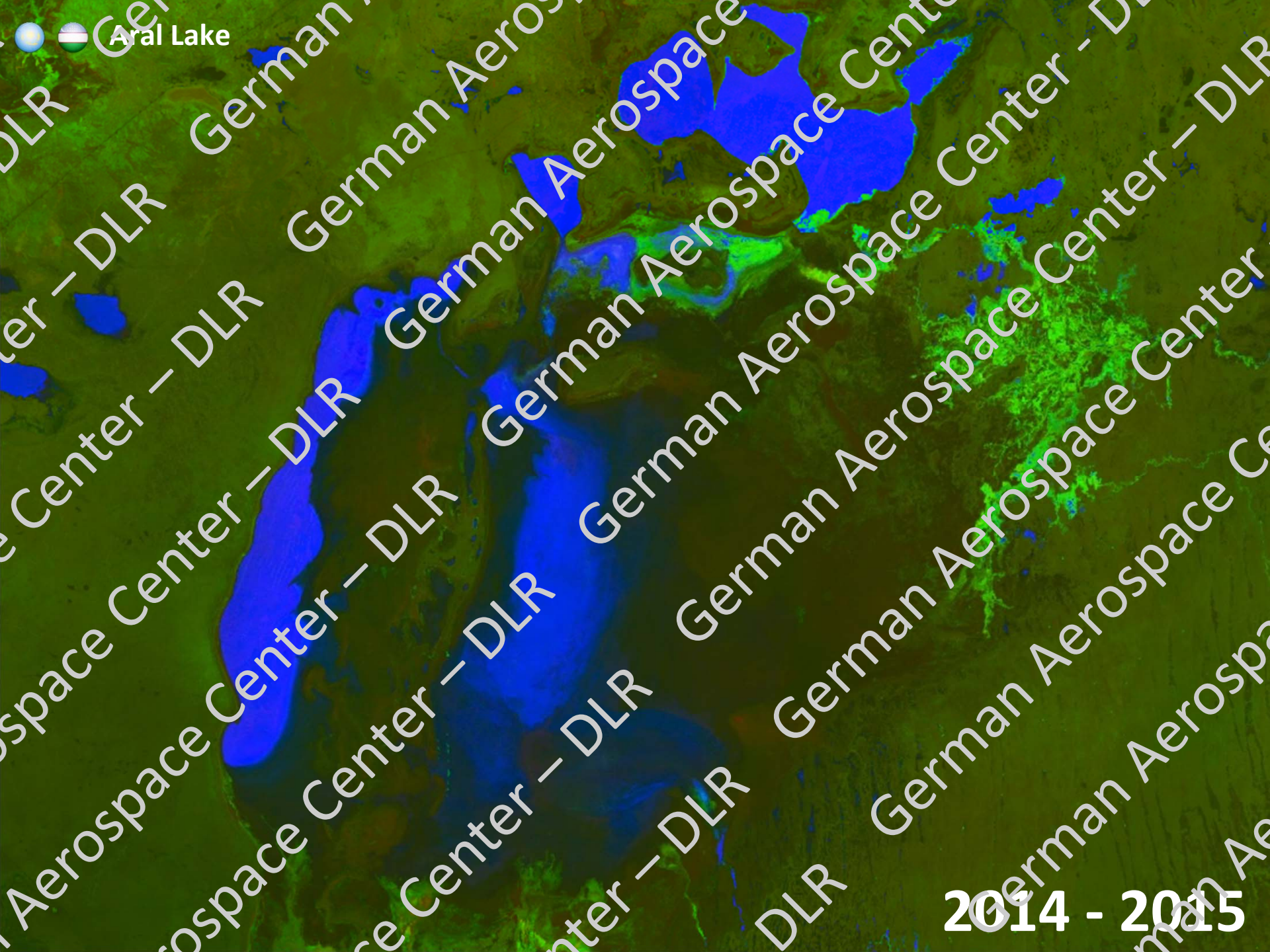
SPATIO-TEMPORAL CONSISTENCY

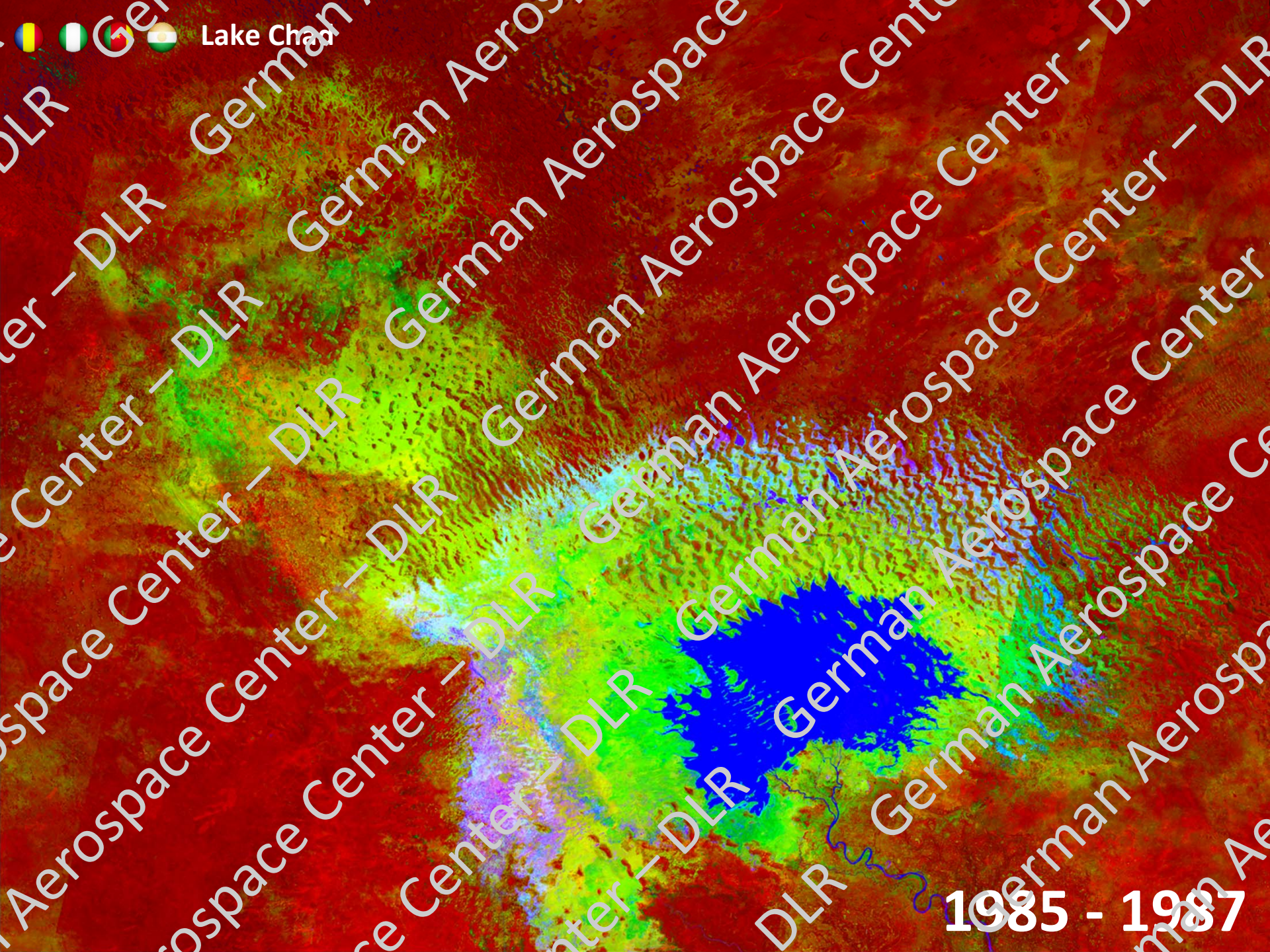
Hypothesis: cloud-free observations per pixels are **sufficient for a robust temporal feature extraction** (e.g., > 7-8 empirically proved to be a reasonable number);

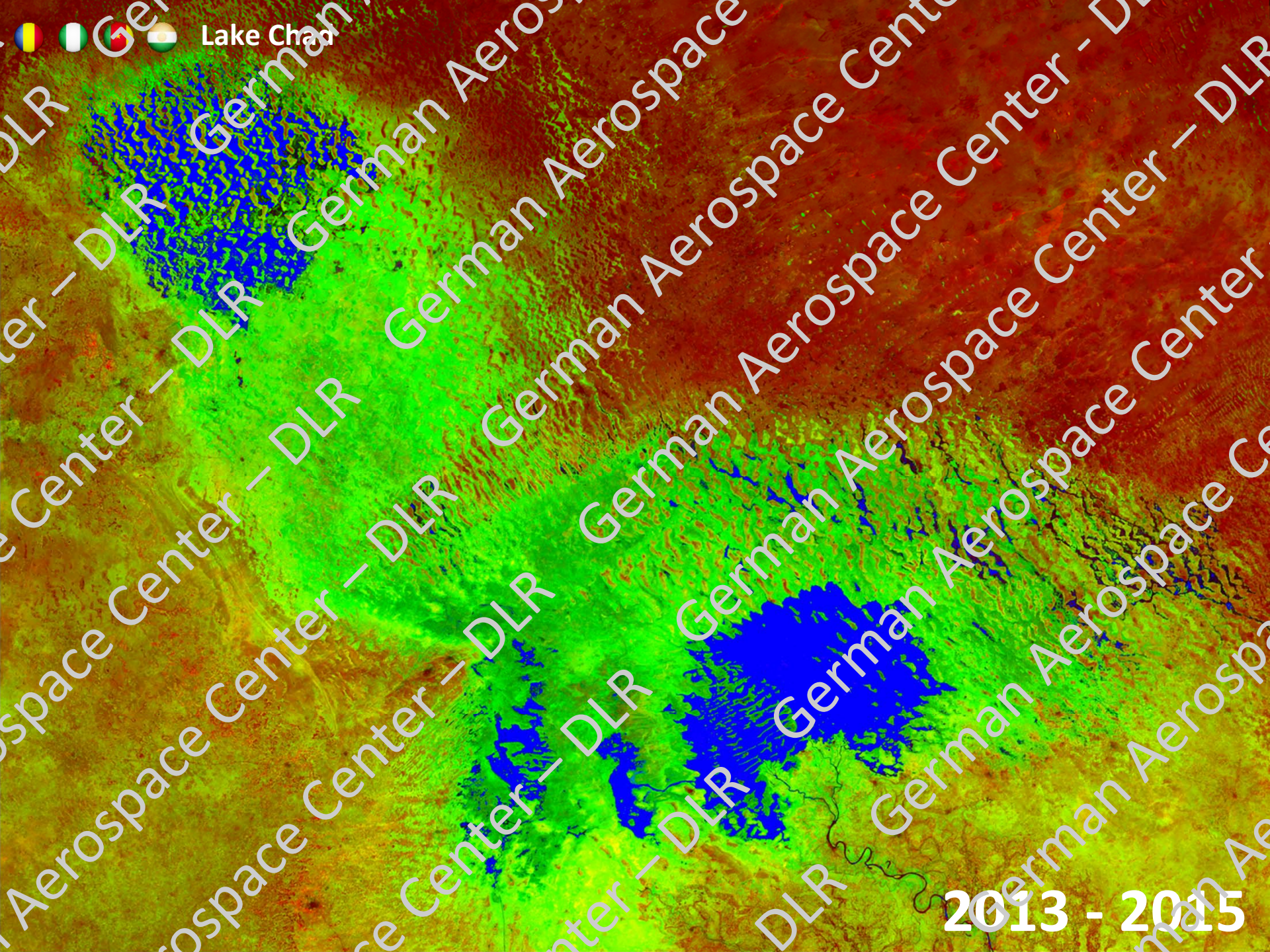
Thesis: **reliable comparison between statistics computed over different areas, as well as over time** (e.g., 30-year Landsat-5/7/8).

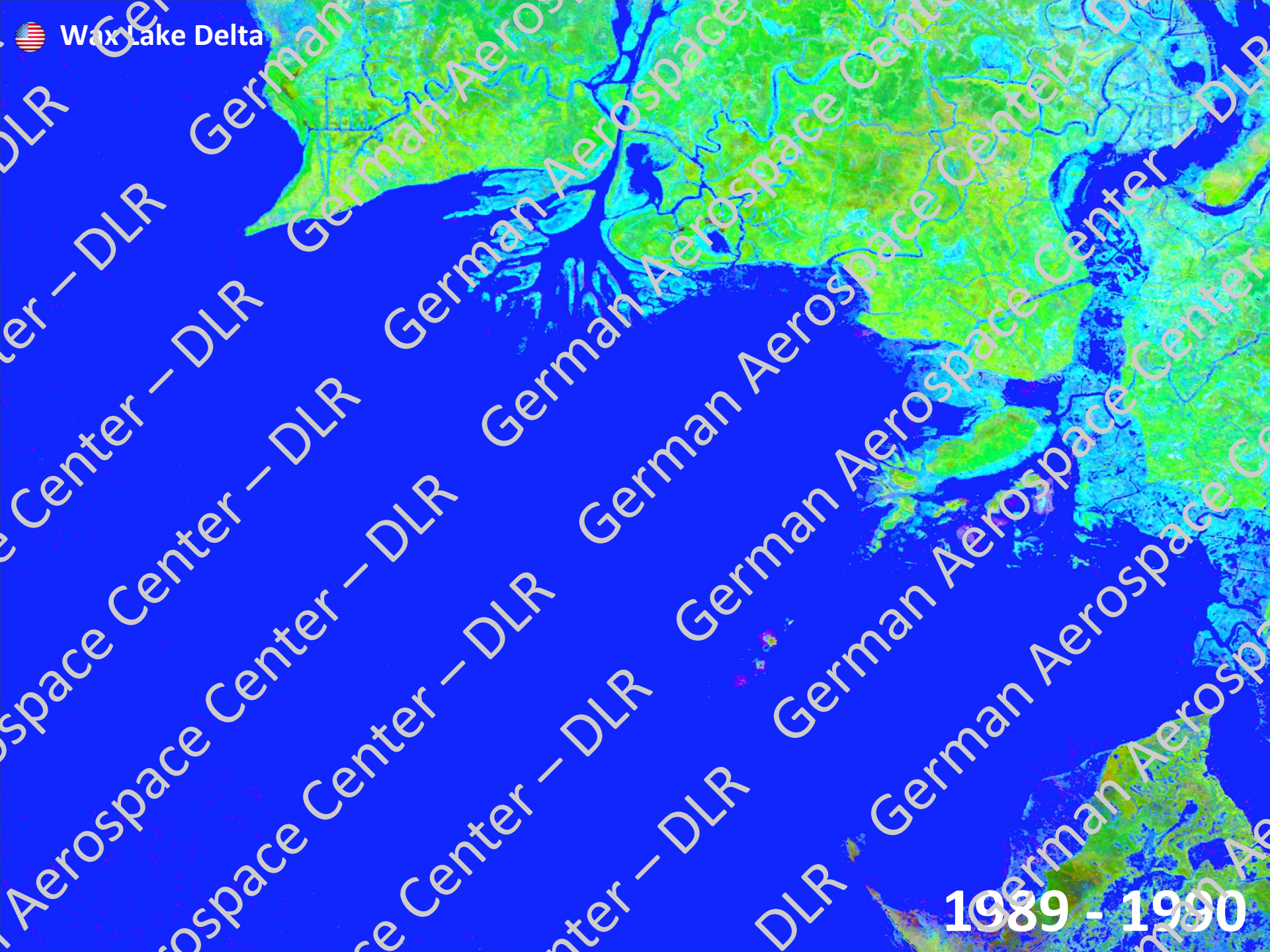
→ High support when addressing **DOMAIN ADAPTATION** problems.

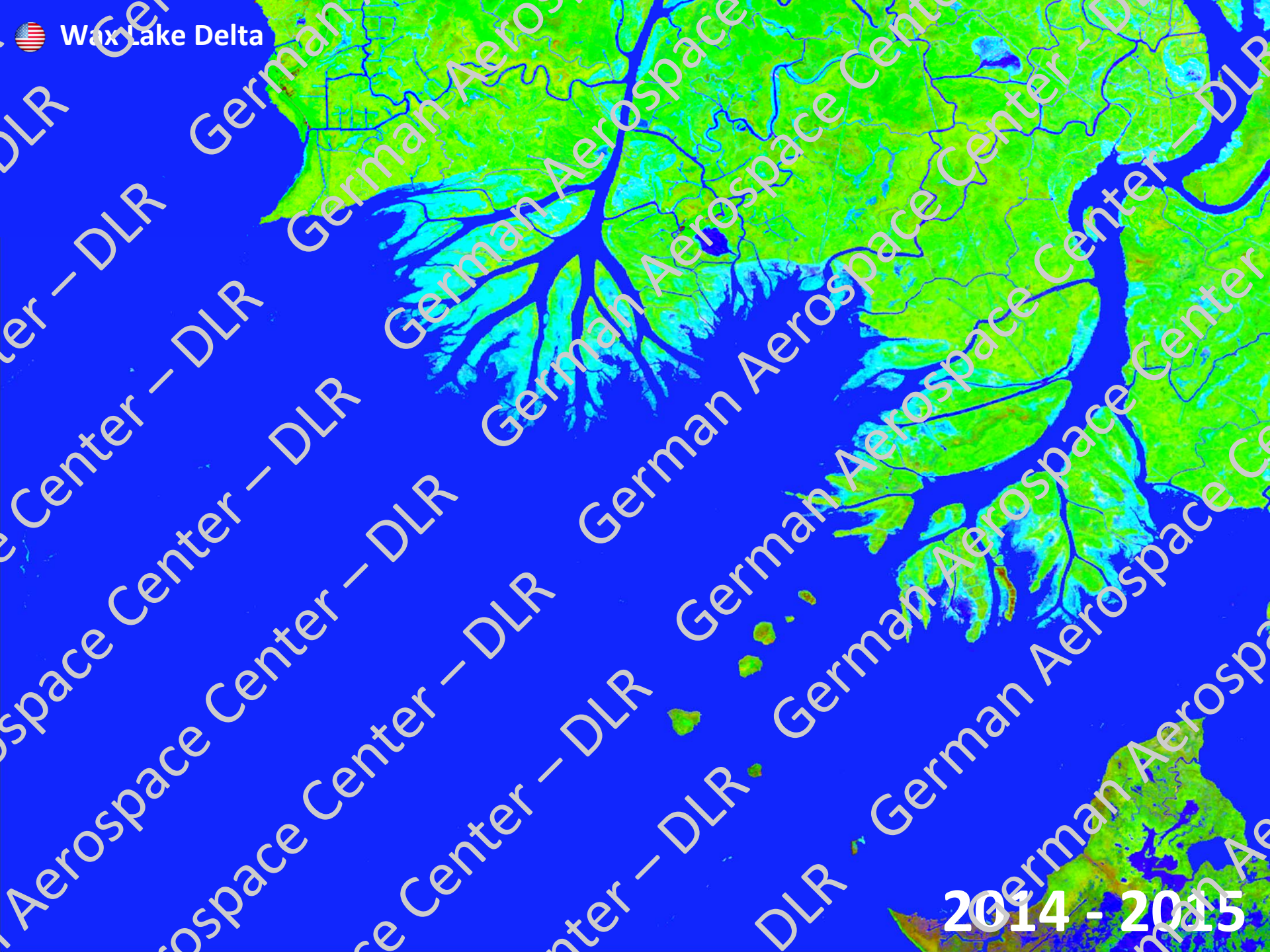

Aral Lake
German Aerospace Center – DLR
1984 - 1985


Aral Lake
German Aerospace Center – DLR
2014 - 2015


Lake Chad
German Aerospace Center – DLR
1985 - 1987


Lake Chad
2013 - 2015
German Aerospace Center – DLR


Wax Lake Delta
German Aerospace Center – DLR
1989 - 1990


Wax Lake Delta
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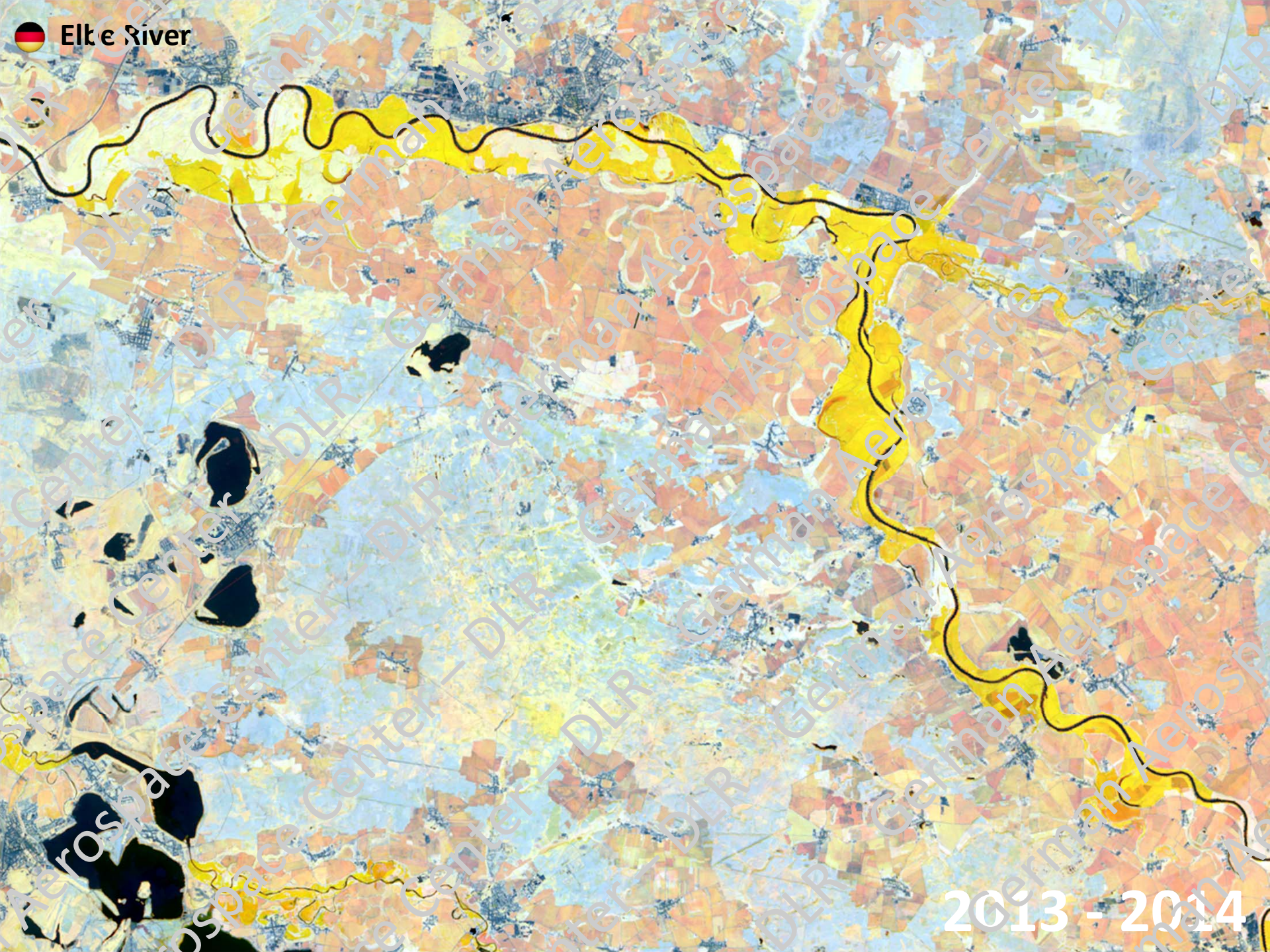
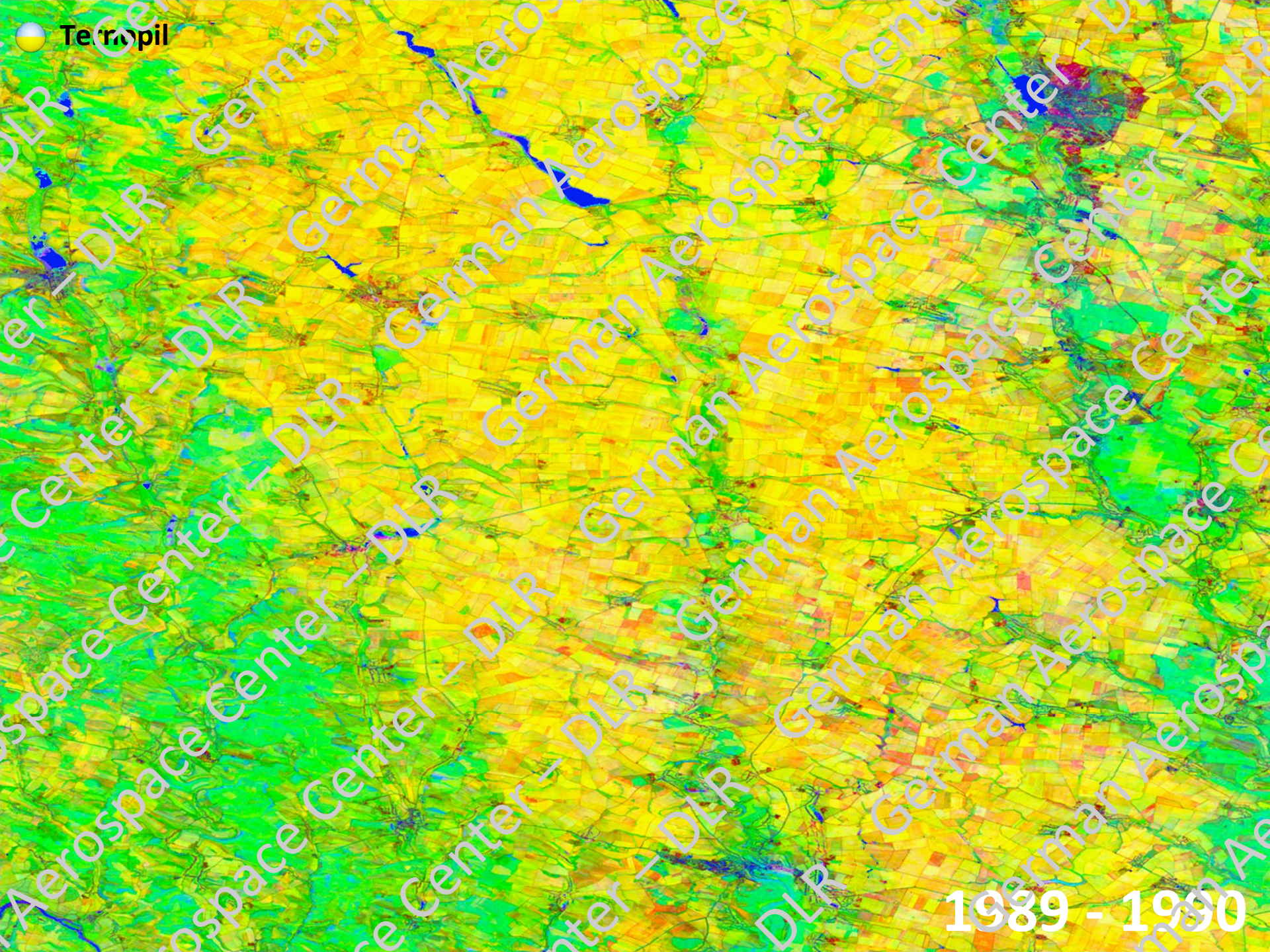
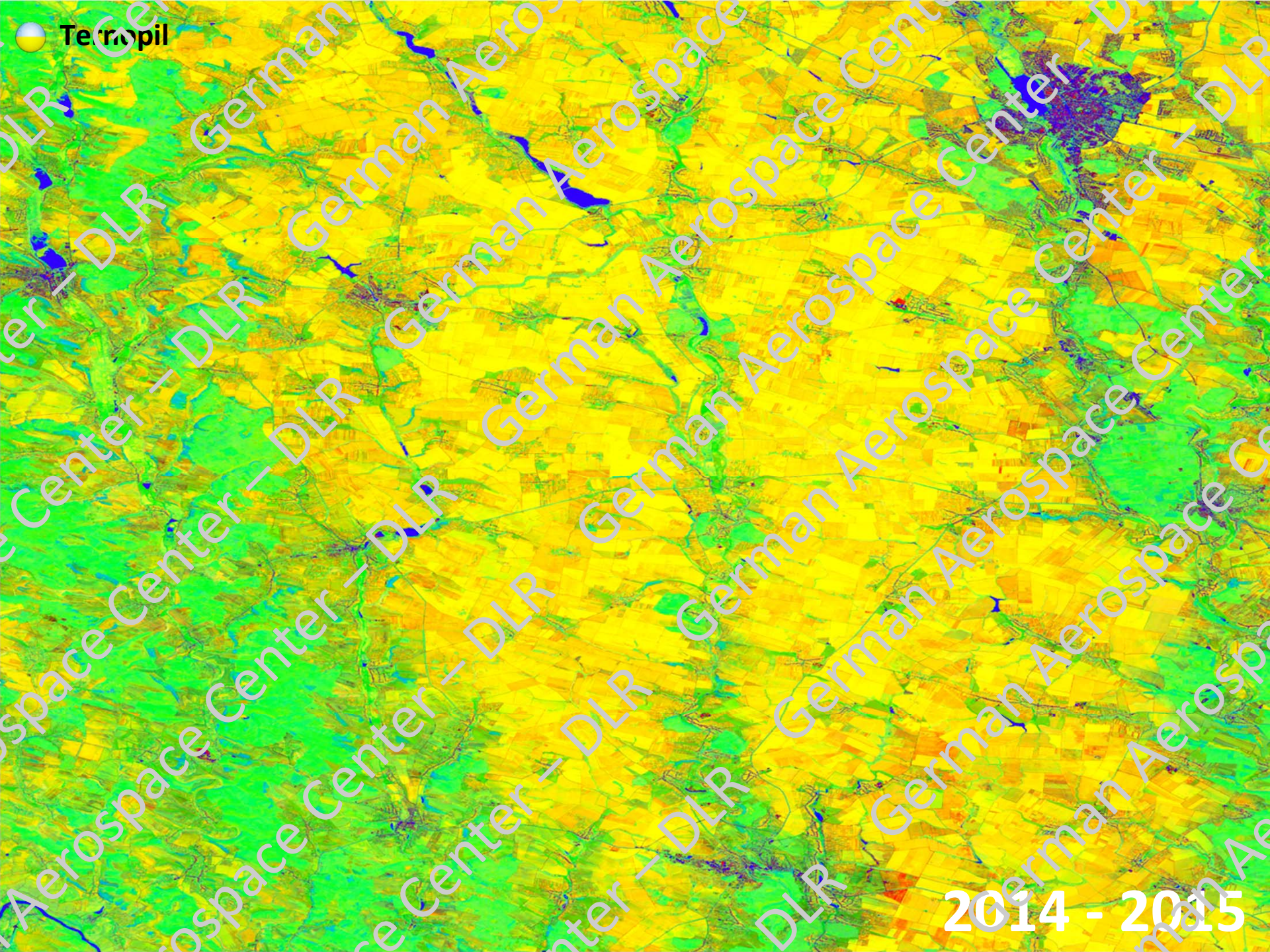
2014 - 2015


Elbe River
2013 - 2014


Ternopil
German Aerospace Center – DLR
1989 - 1990


Ternopil
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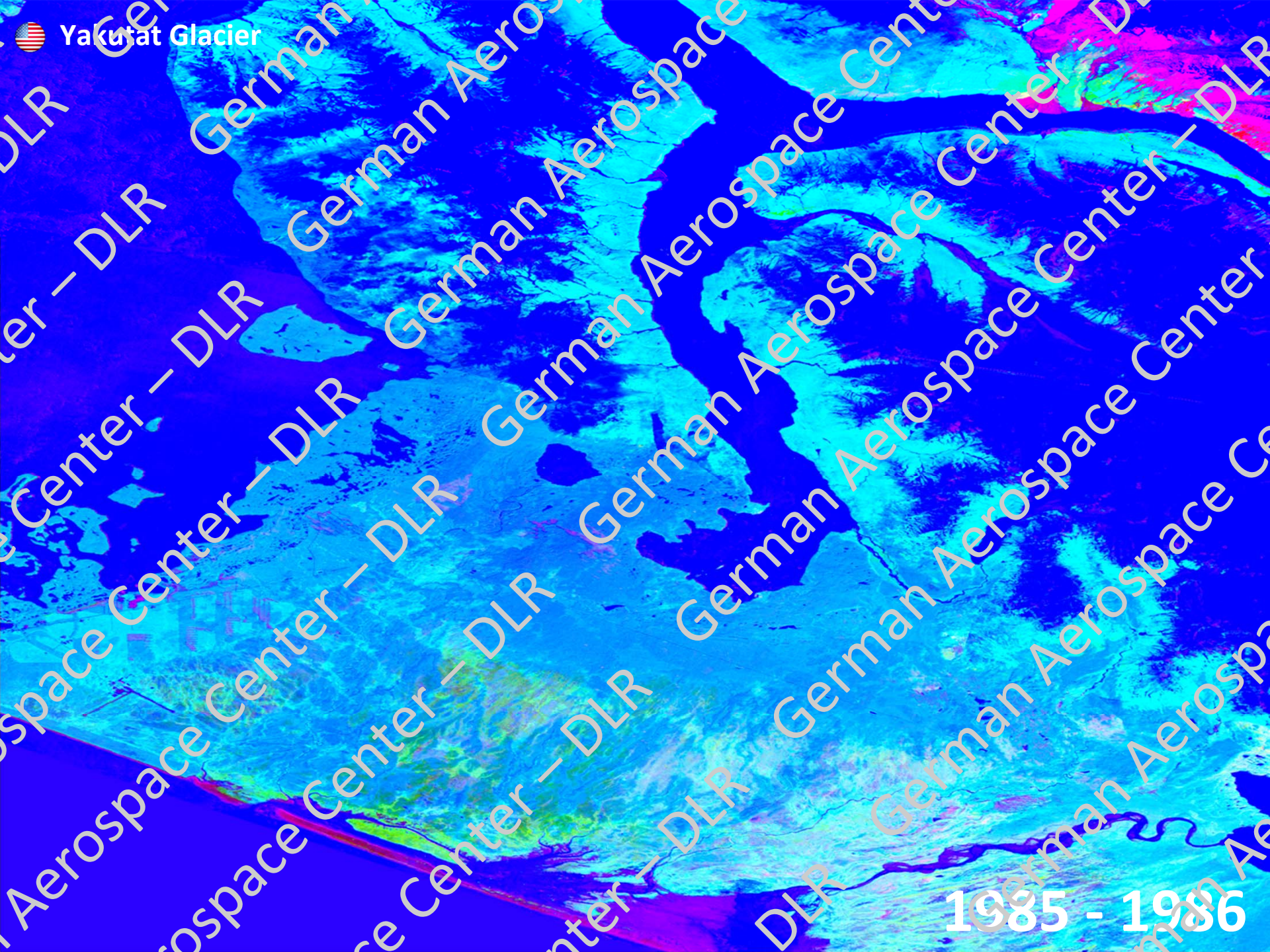
2014 - 2015


Yakutat Glacier
German Aerospace Center – DLR
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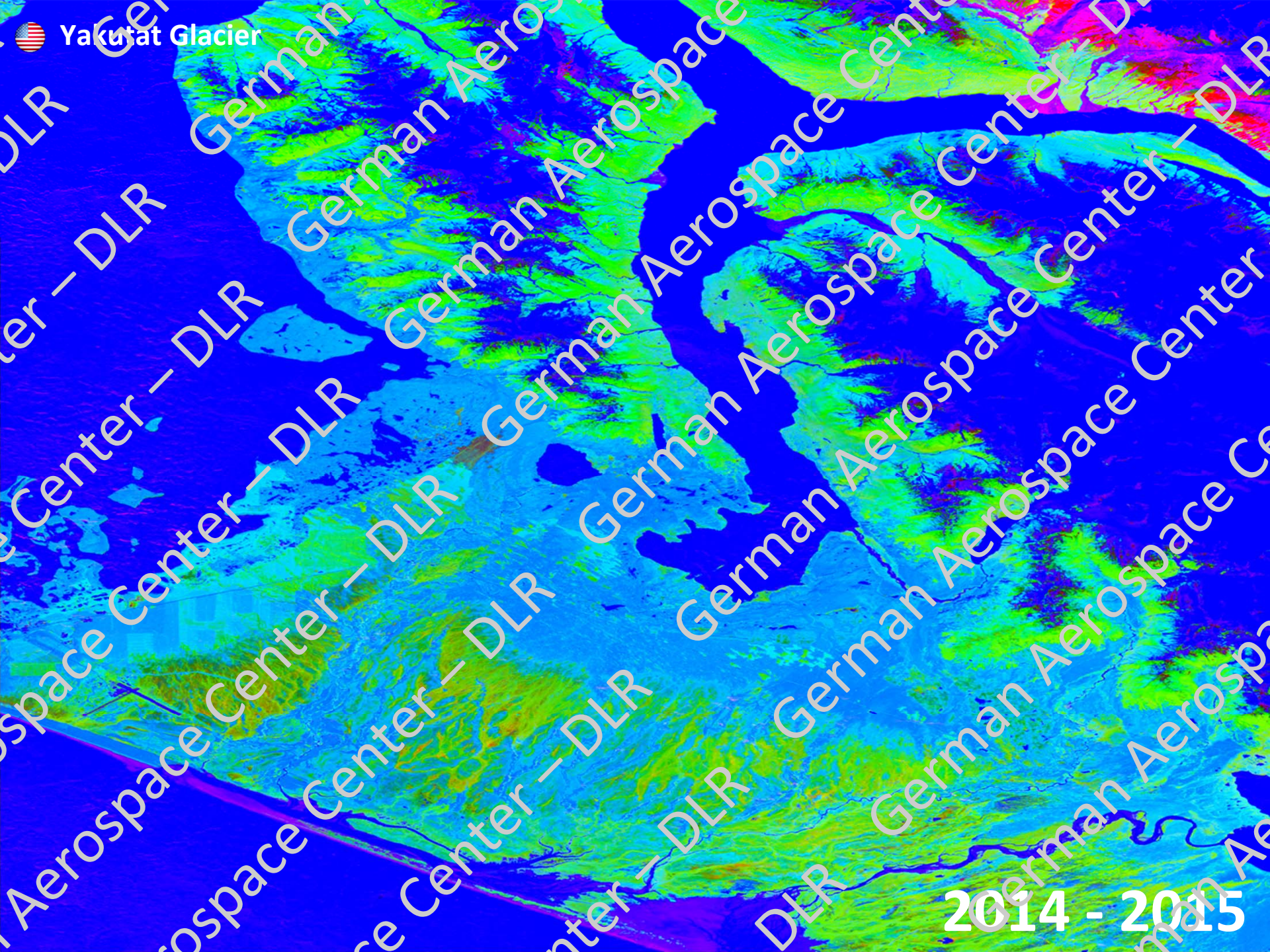
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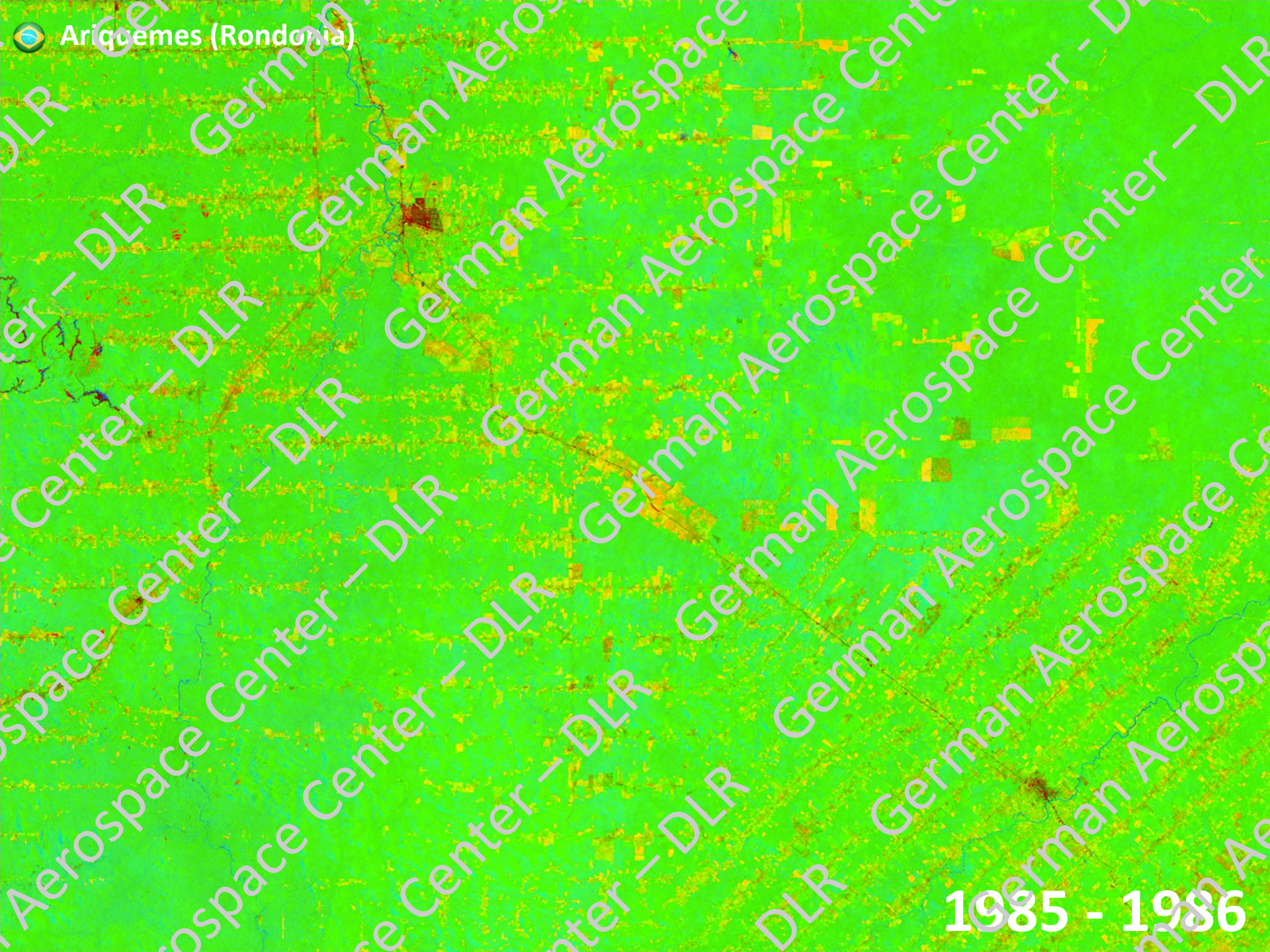
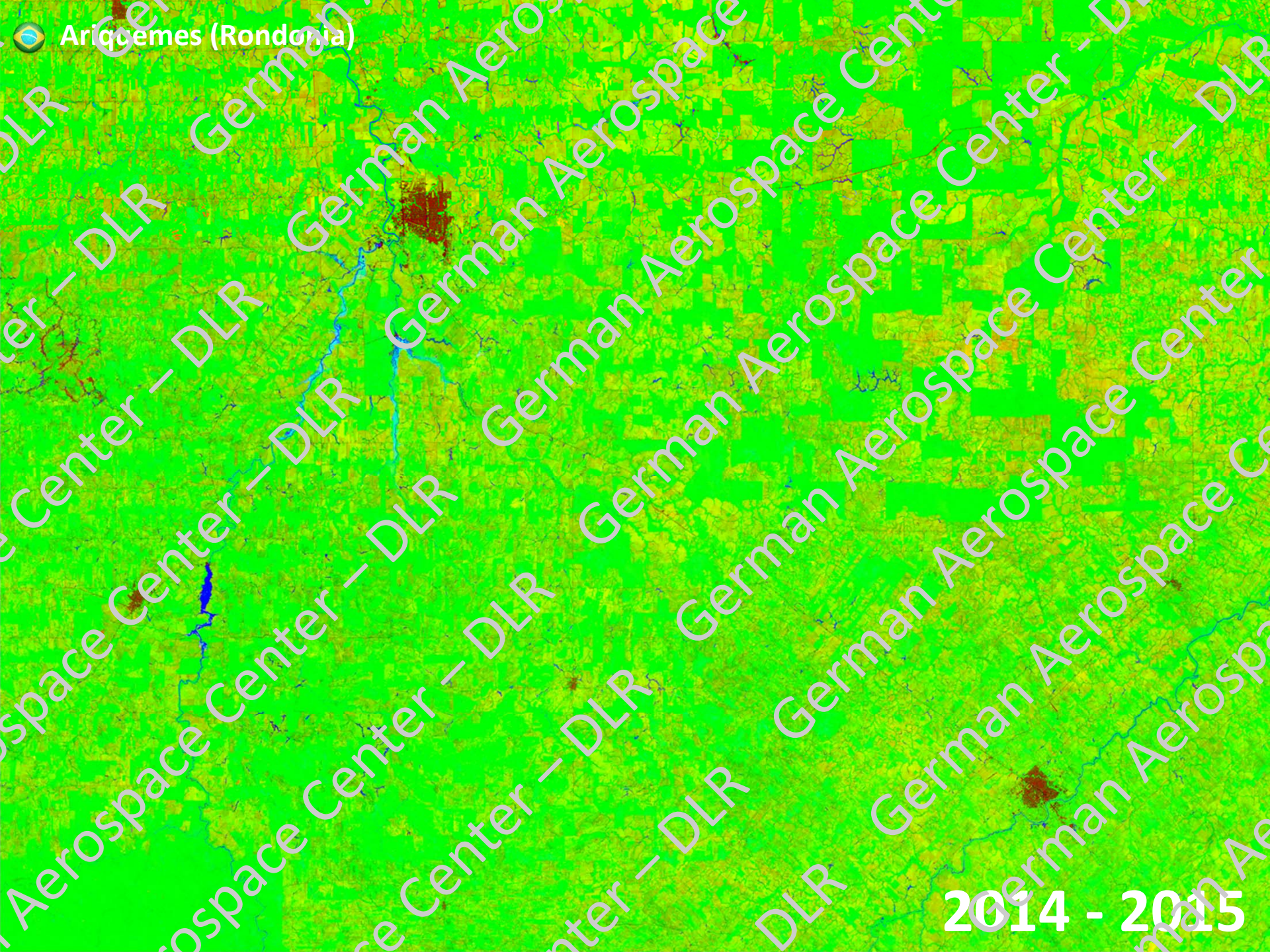

Ariquemes (Rondonia)
German Aerospace Center – DLR
1985 - 1986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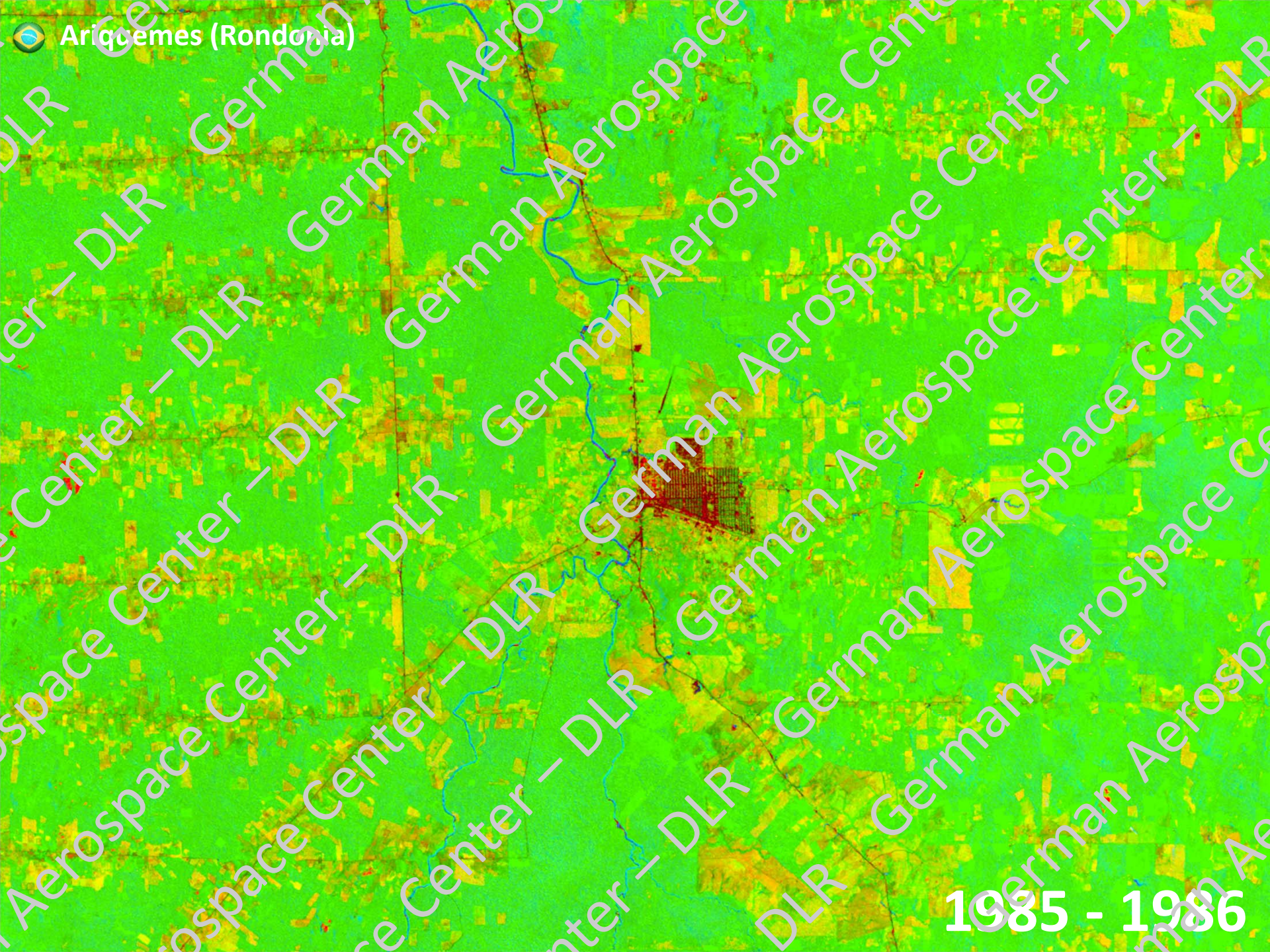
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1985 - 1986
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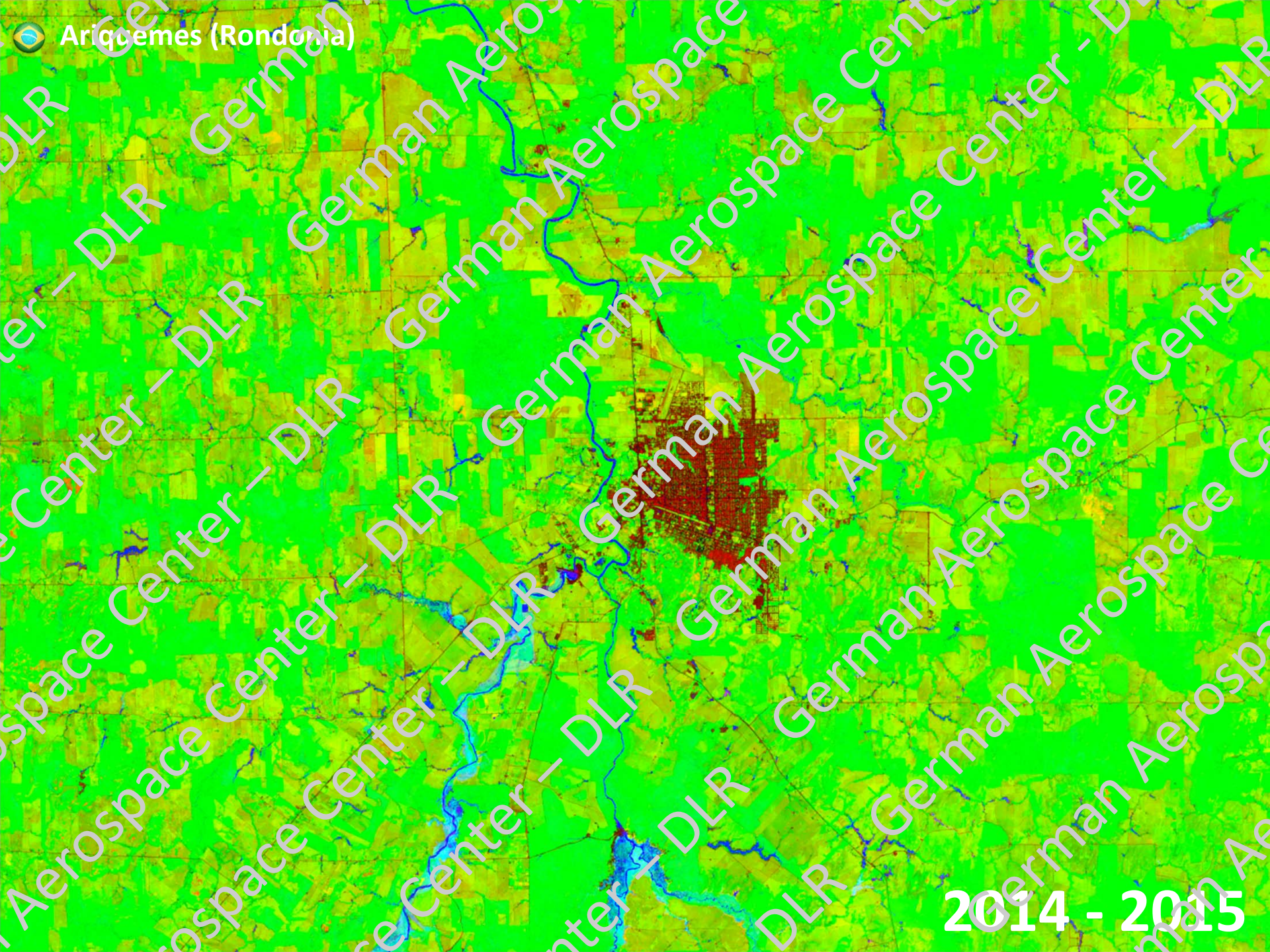
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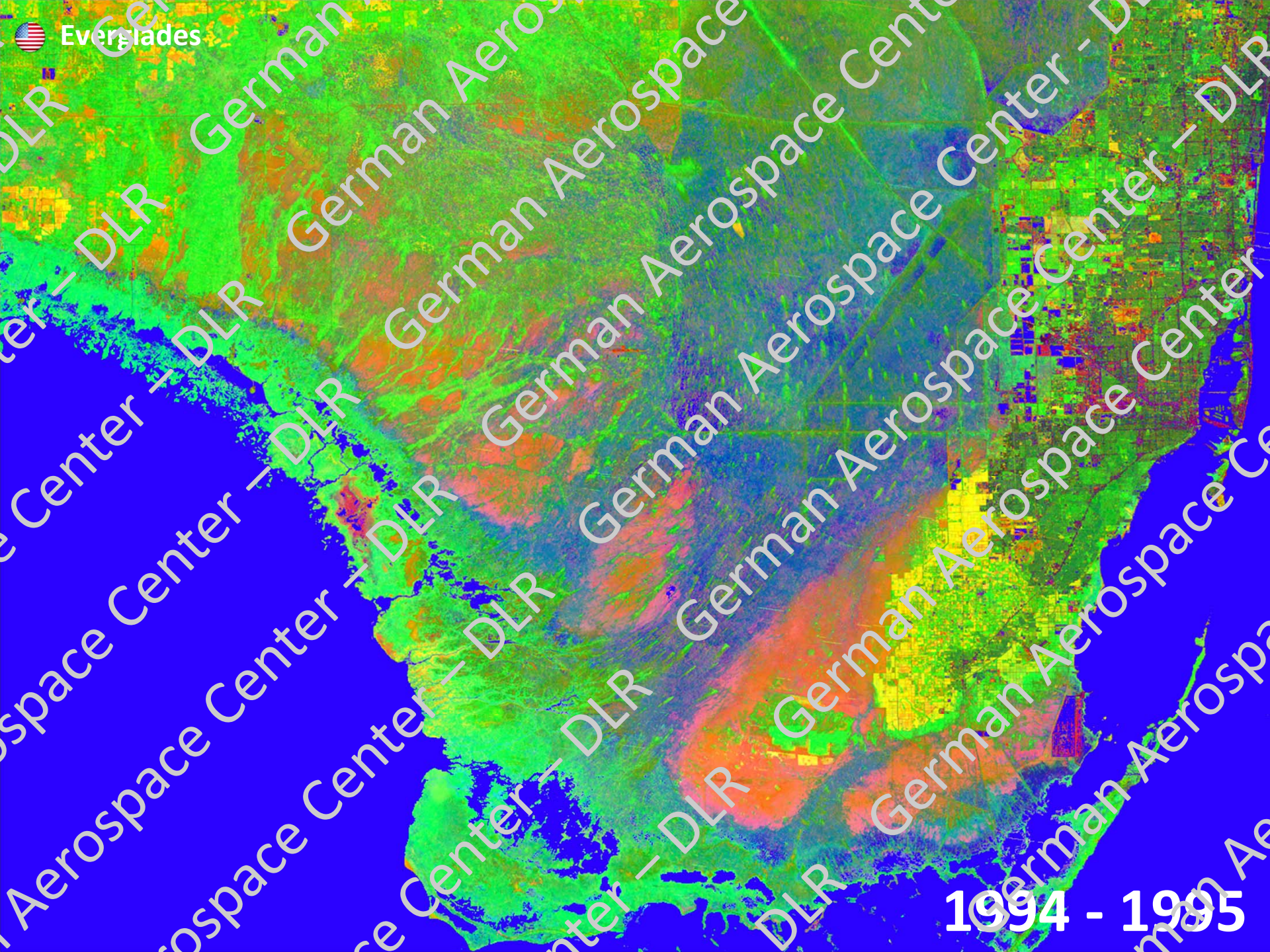
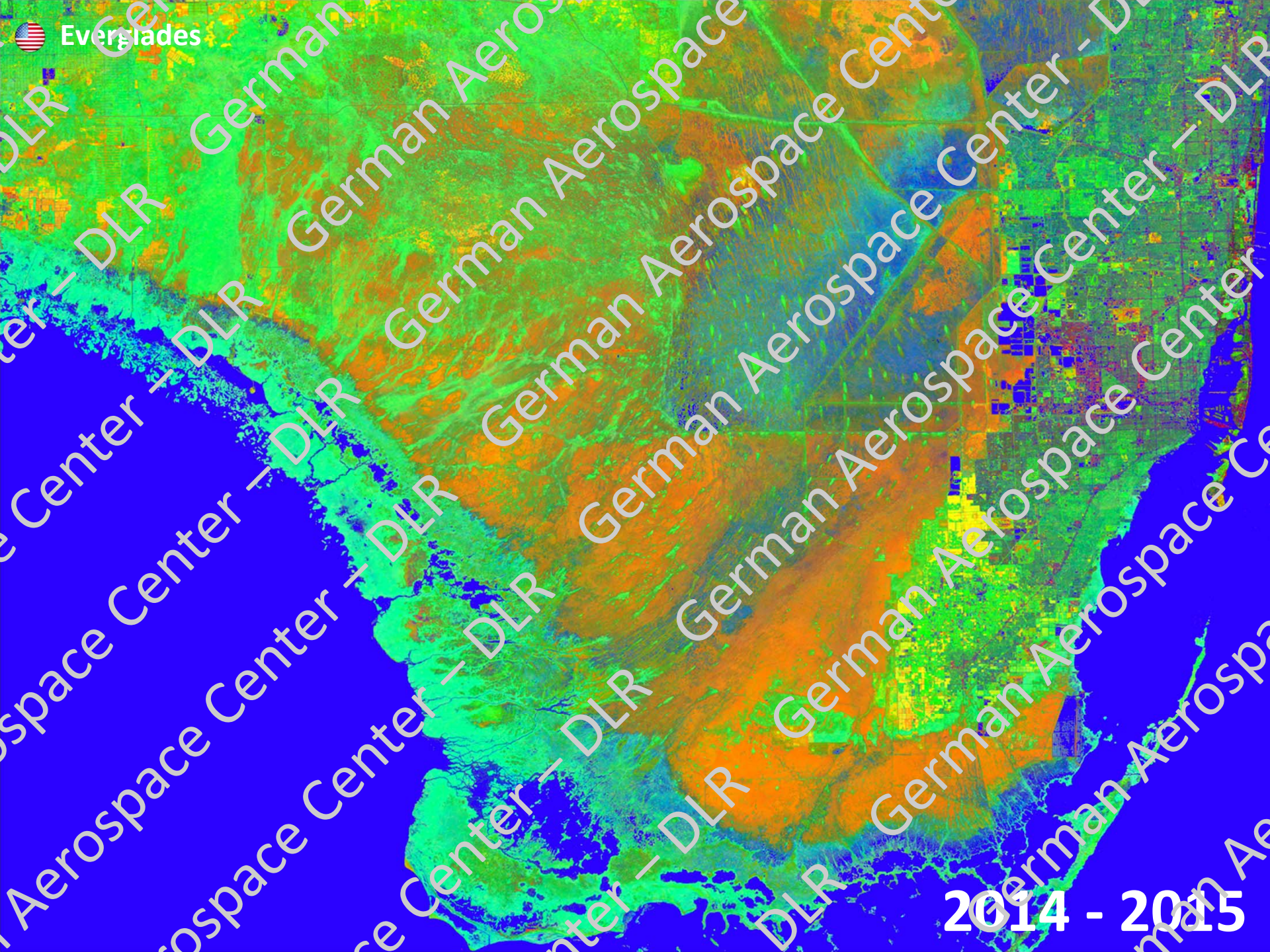
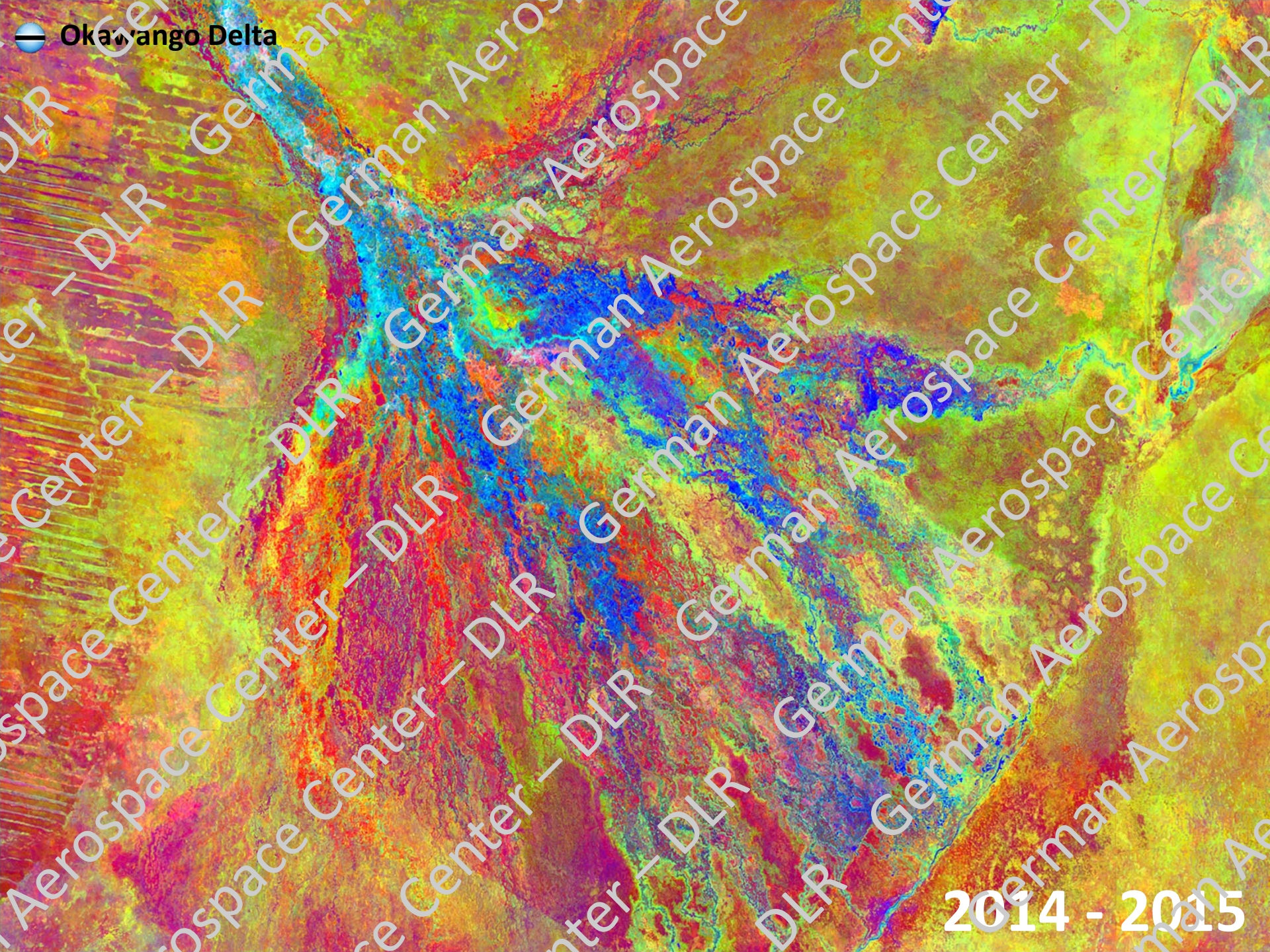
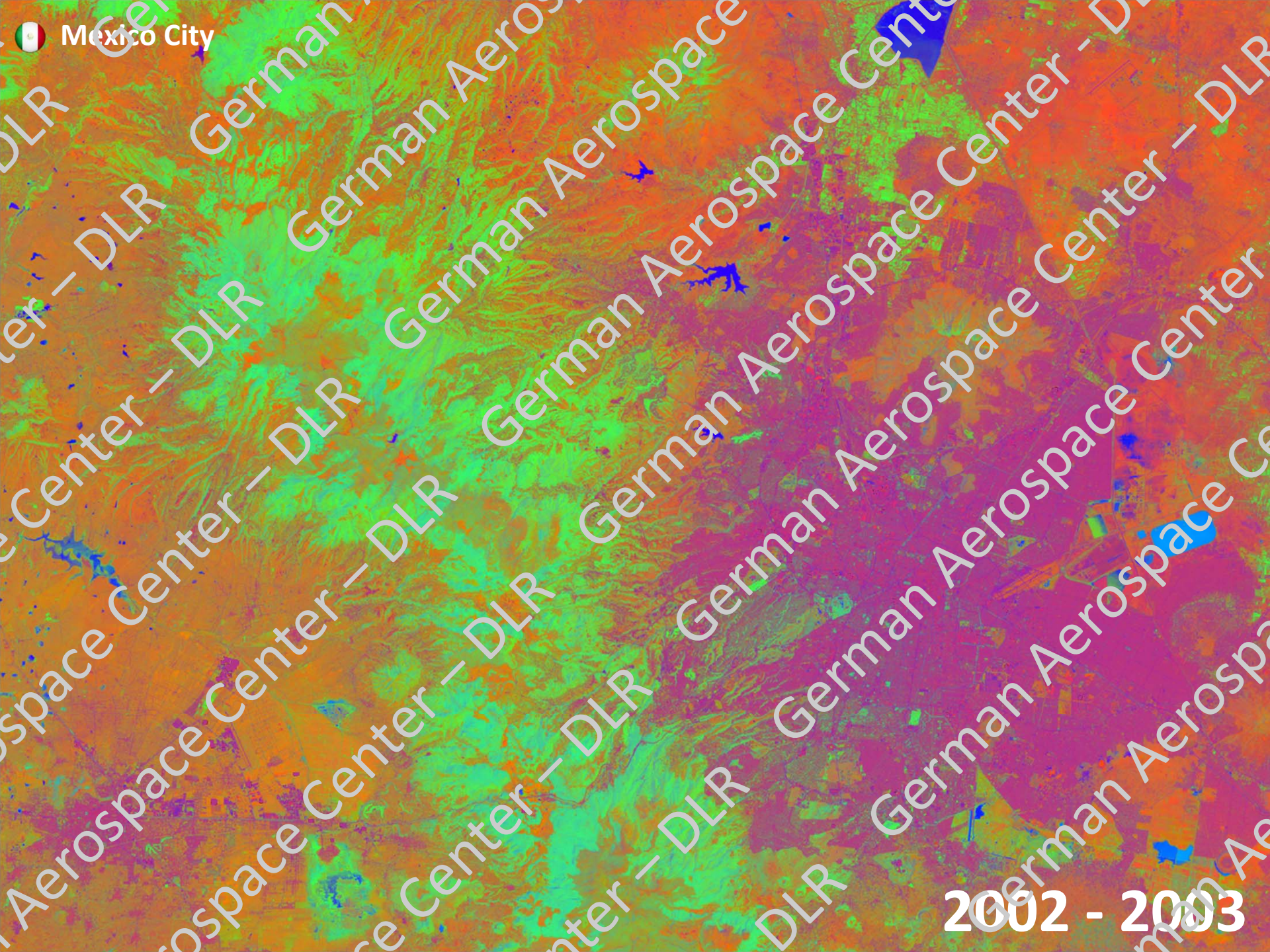
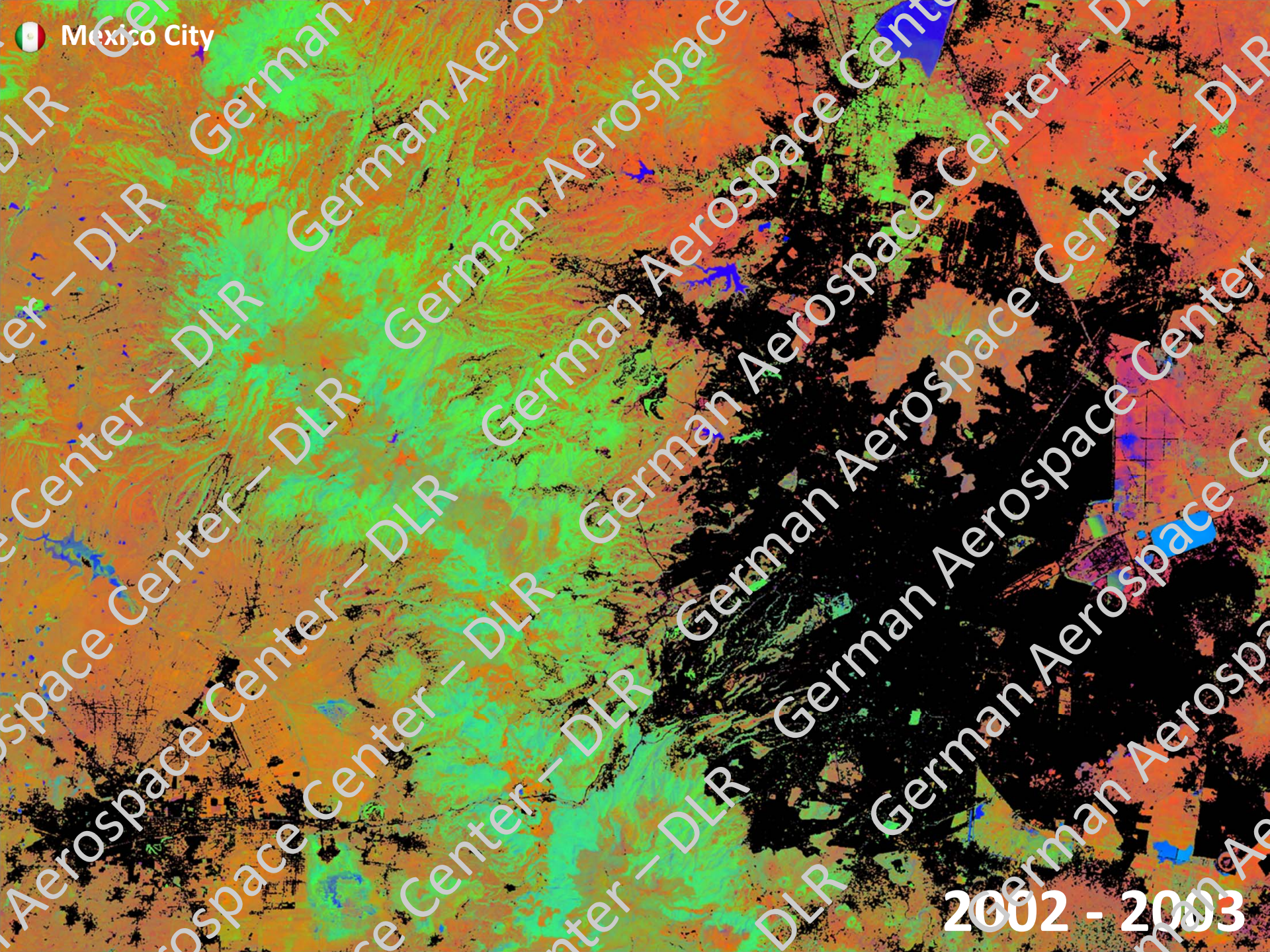
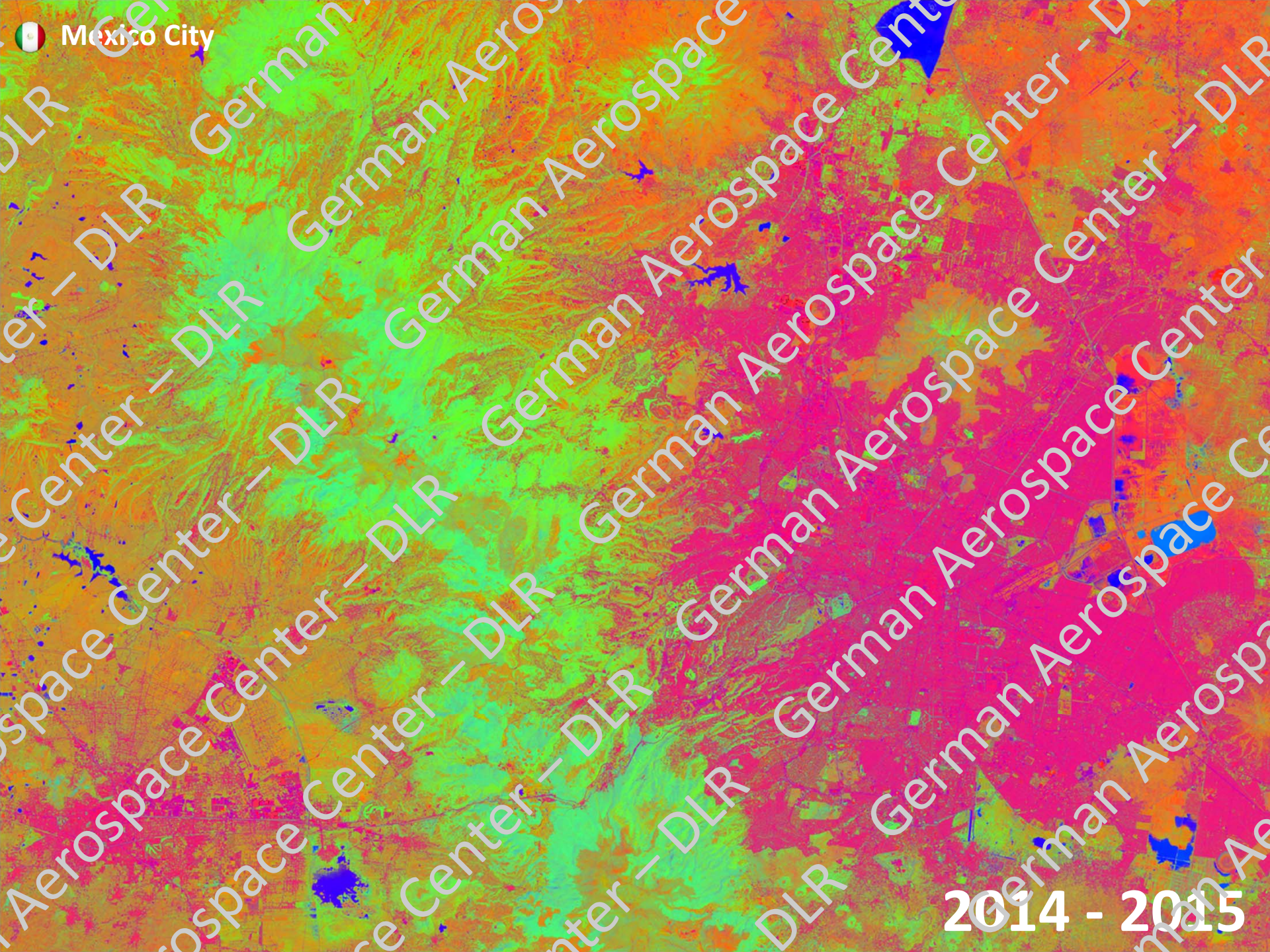

Everglades
German Aerospace Center – DLR
1994 - 1995

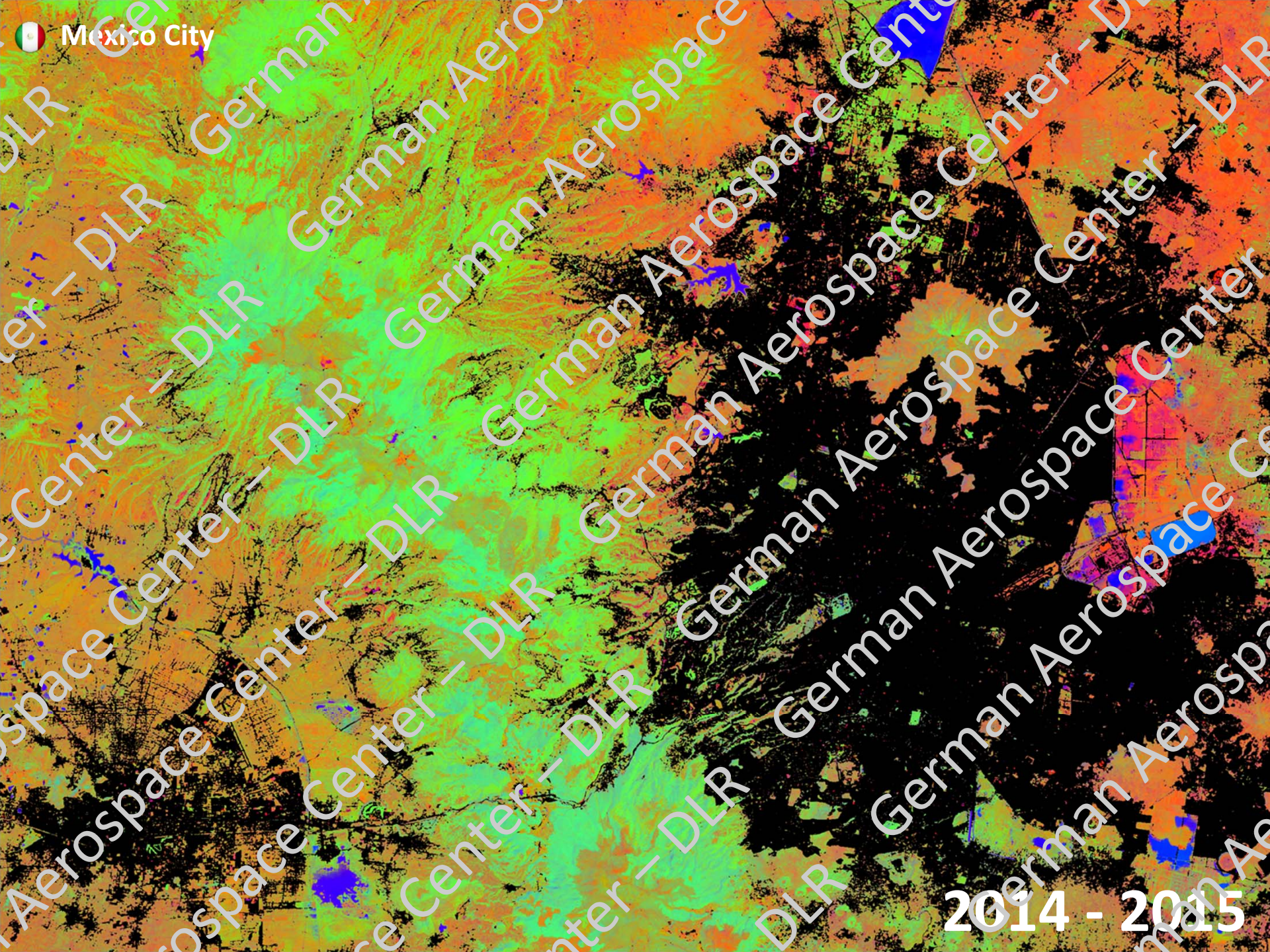

Everglades
German Aerospace Center – DLR
2014 - 2015


Okavango Delta
German Aerospace Center – DLR
2014 - 2015


Mexico City
German Aerospace Center – DLR
2002 - 2003


Mexico City
German Aerospace Center – DLR
2002 - 2003


Mexico City
2014 - 2015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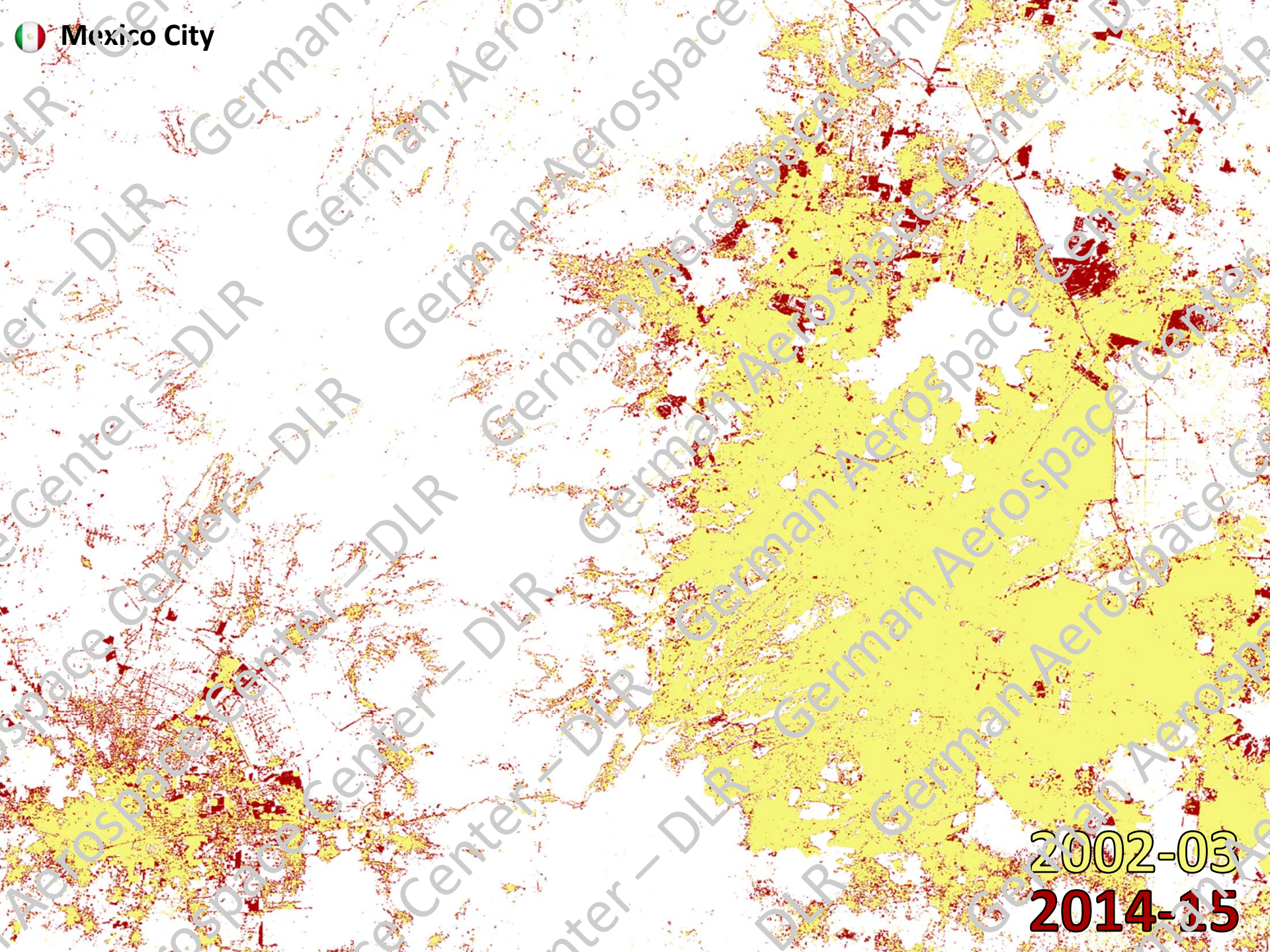
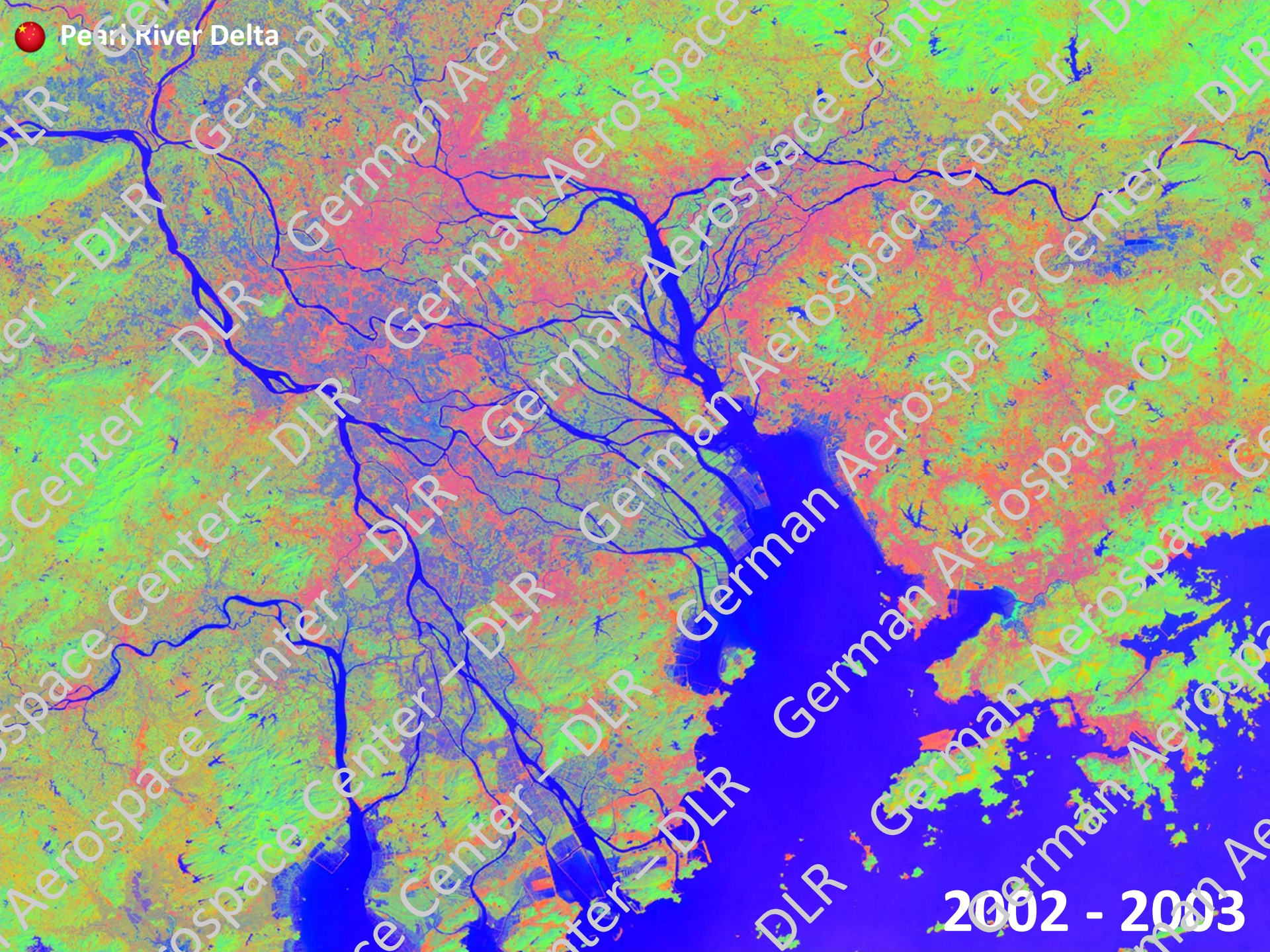
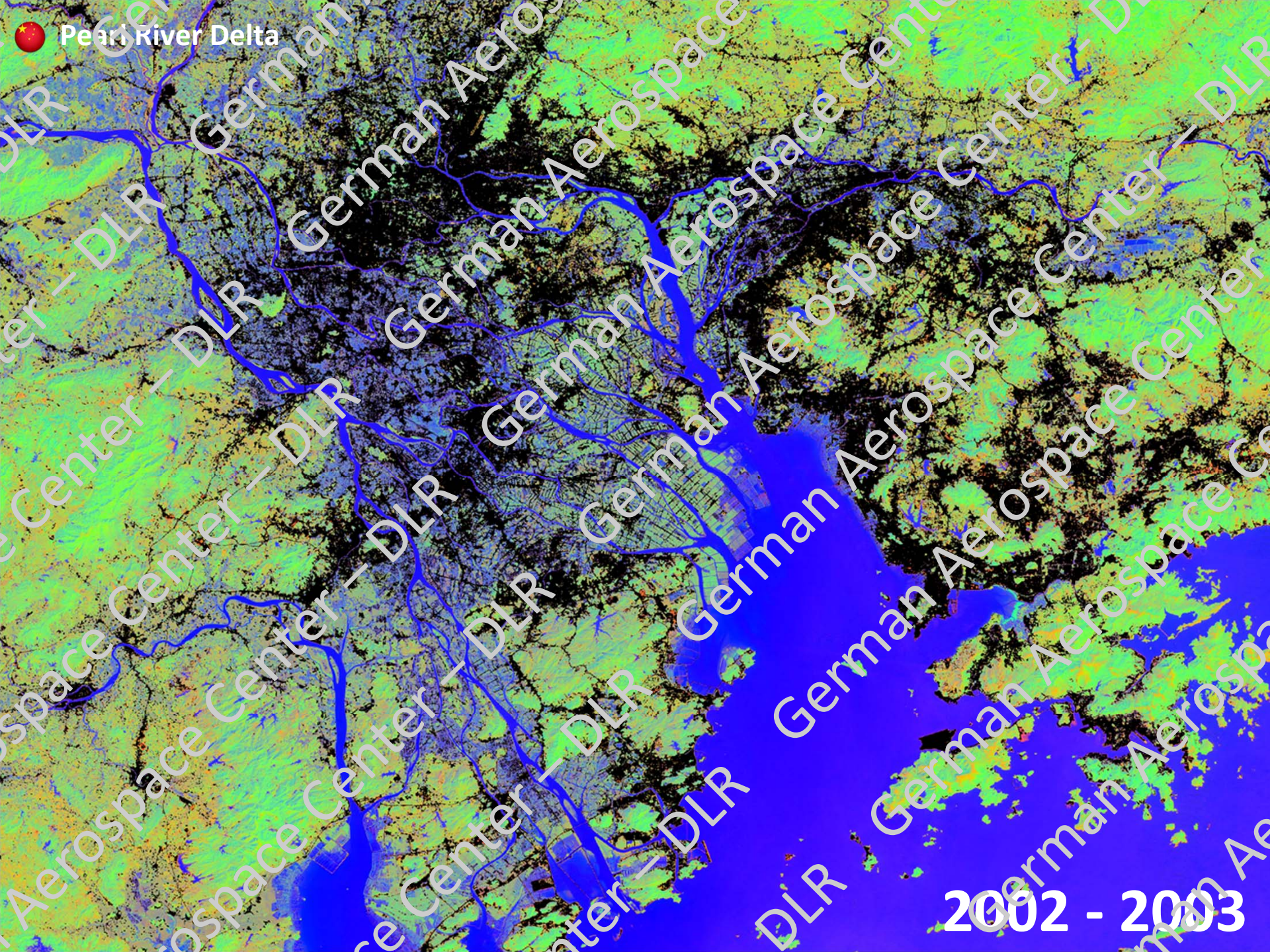
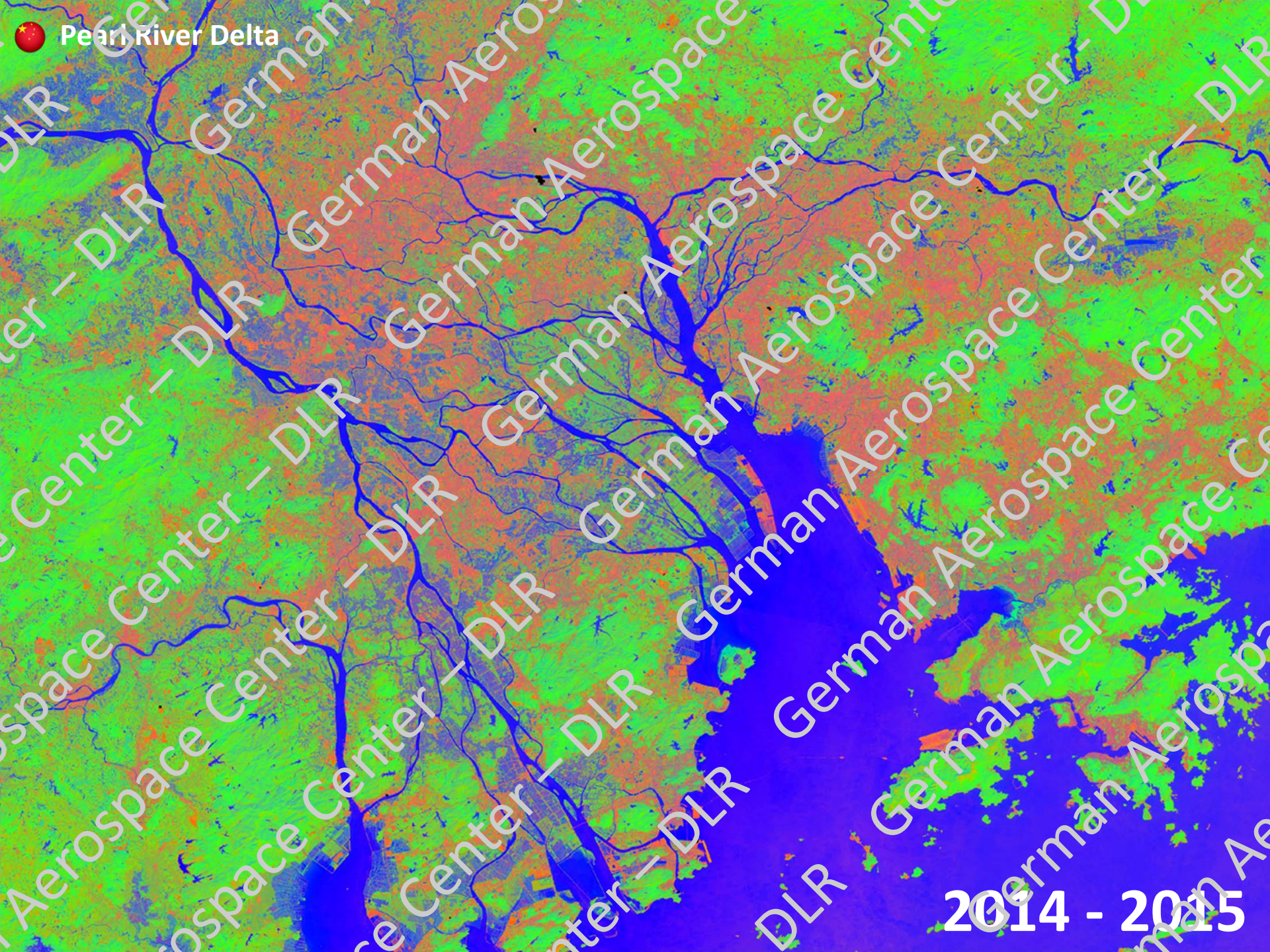
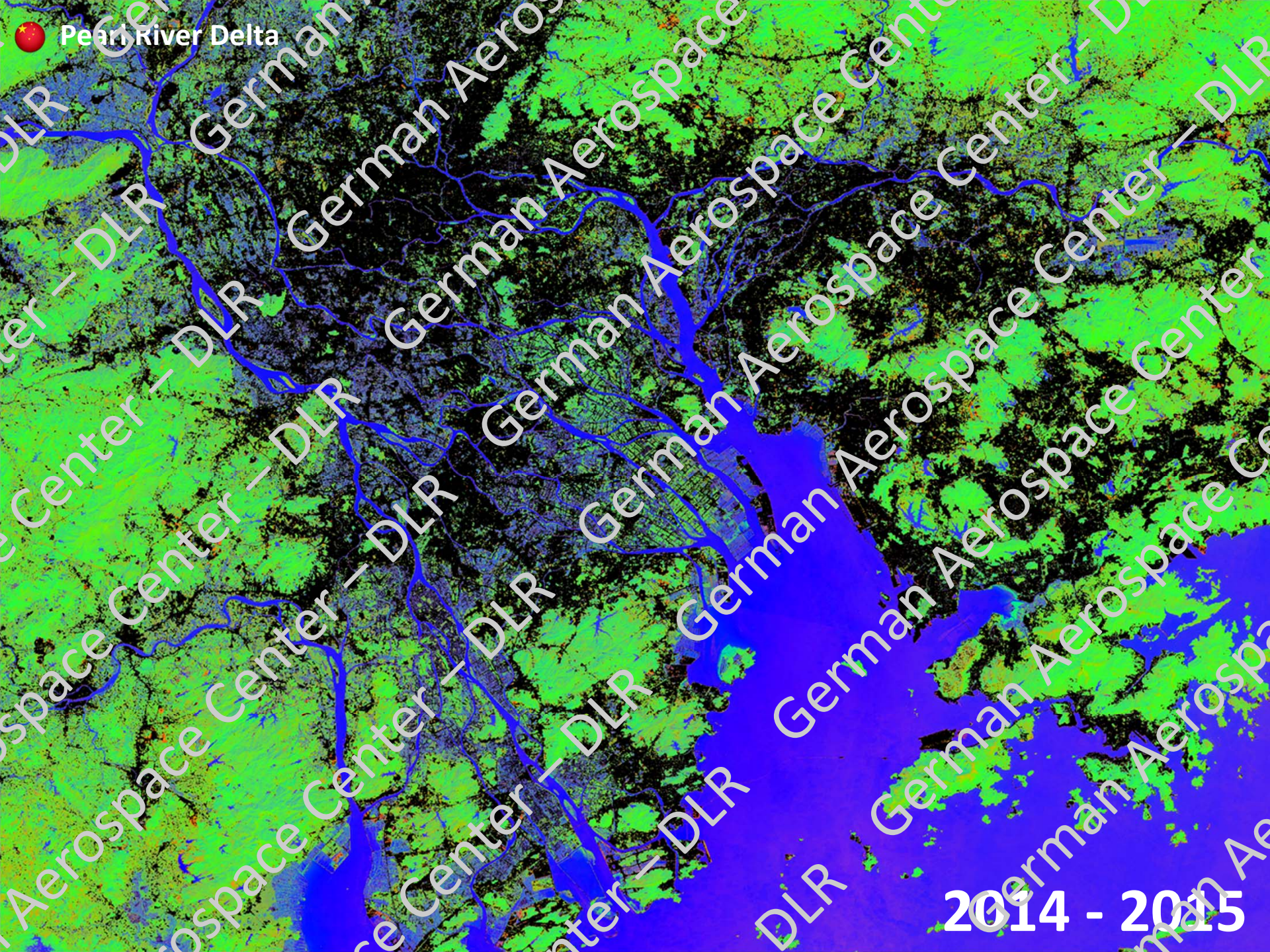
2014 - 2015

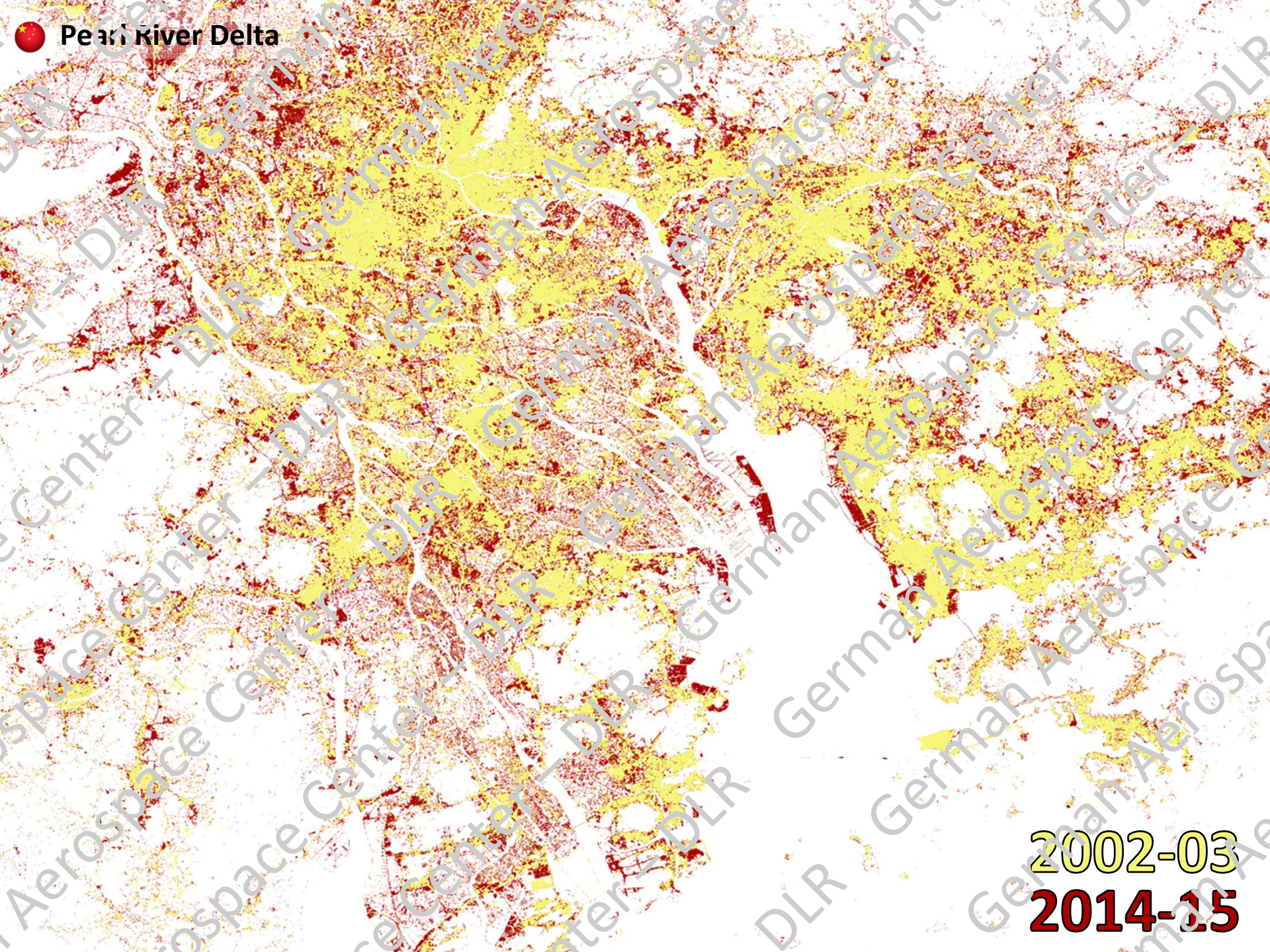

Mexico City
2002-03
2014-15
German Aerospace Center – DLR

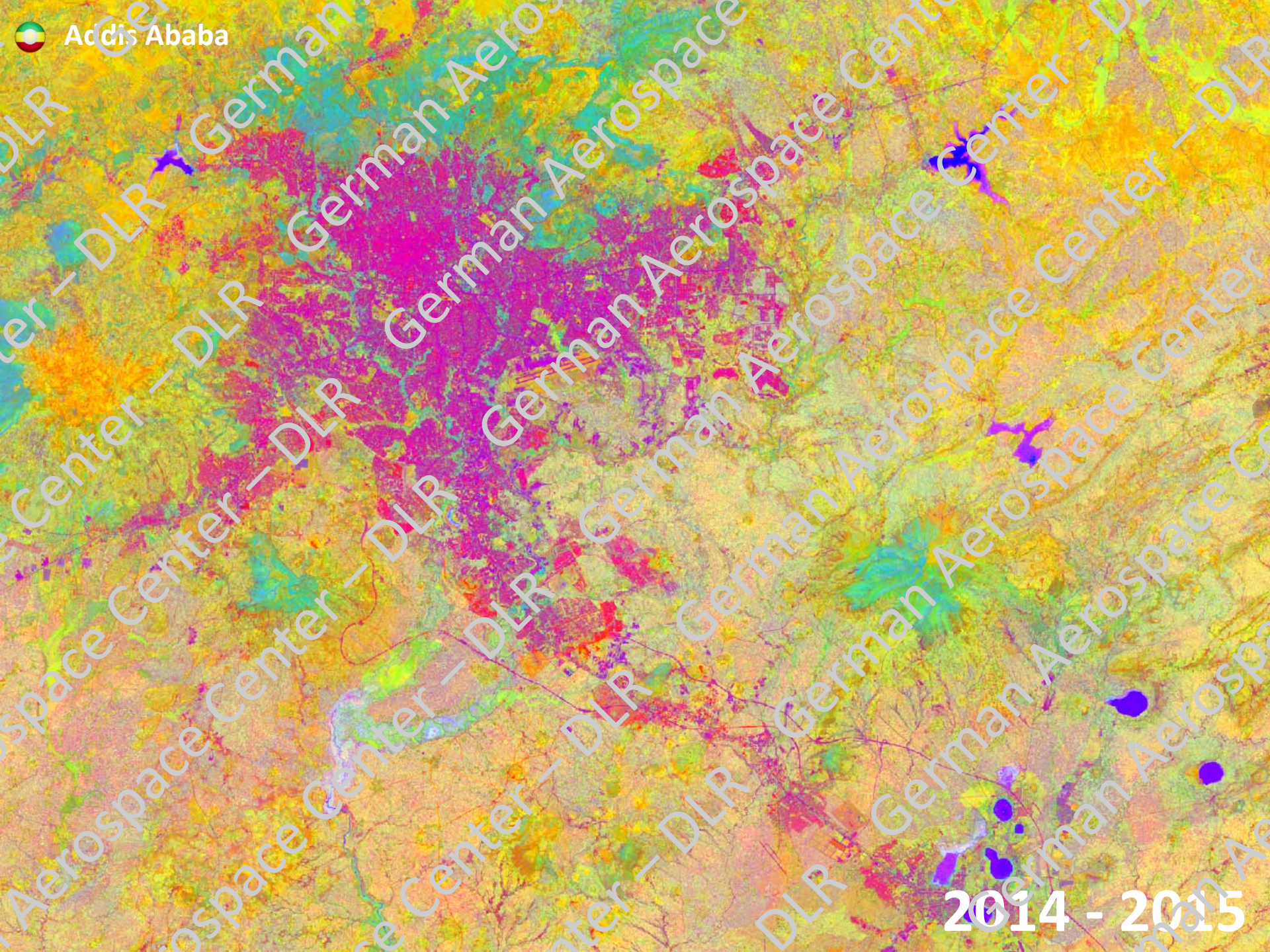

Pearl River Delta
2002 - 2003

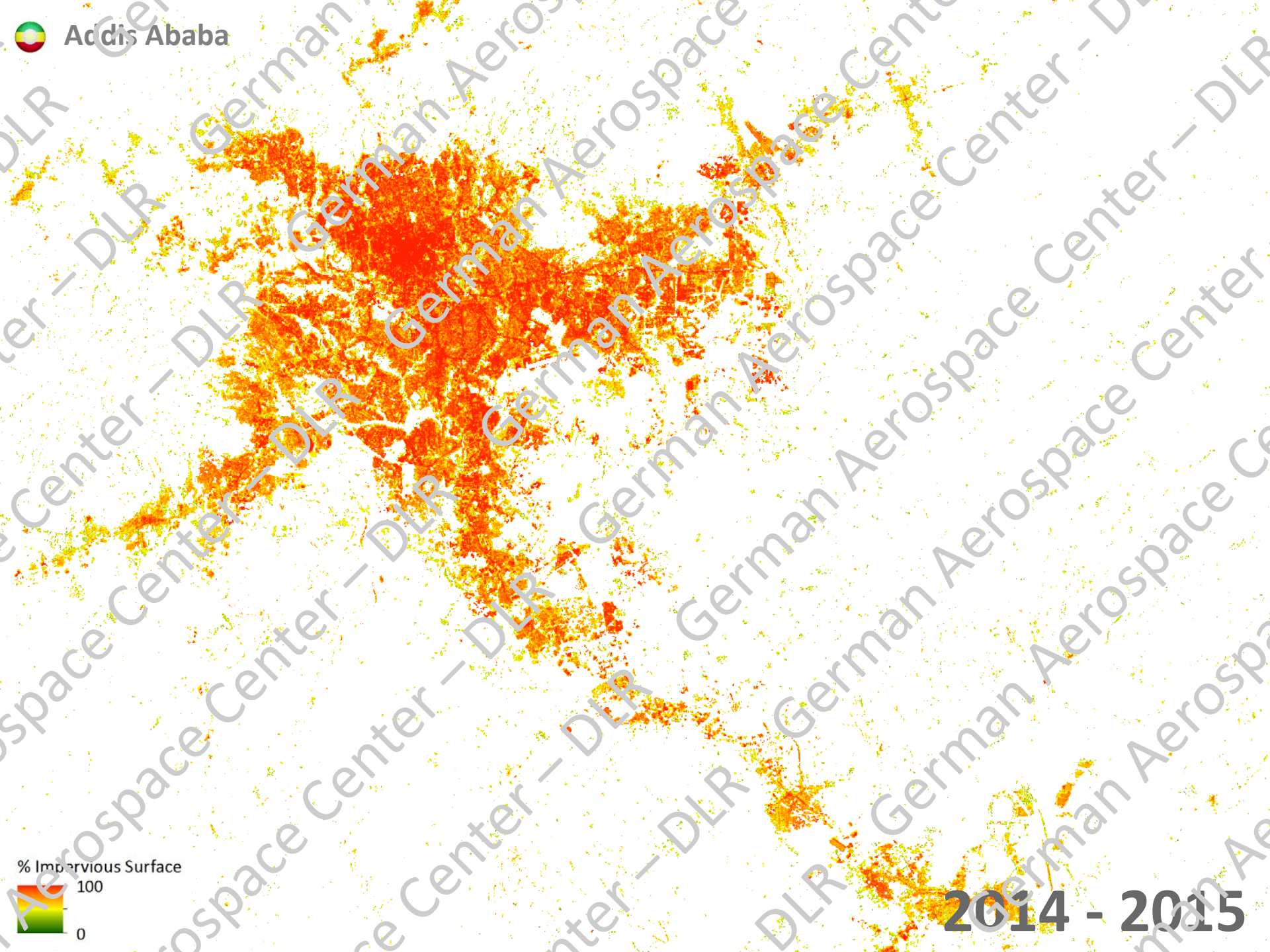

Pearl River Delta
German Aerospace Center – DLR
2002 - 2003

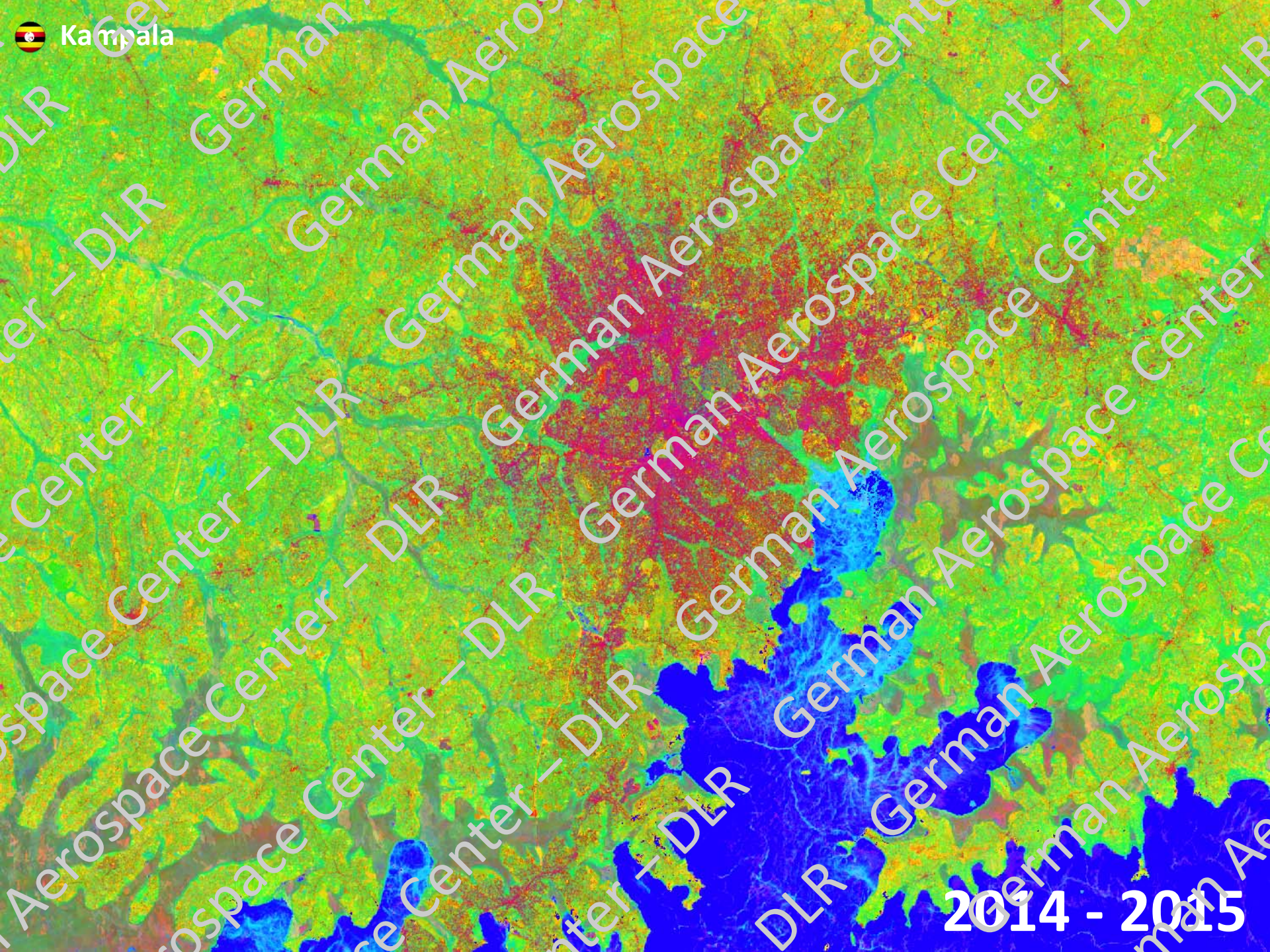

Pearl River Delta
German Aerospace Center – DLR
2014 - 2015

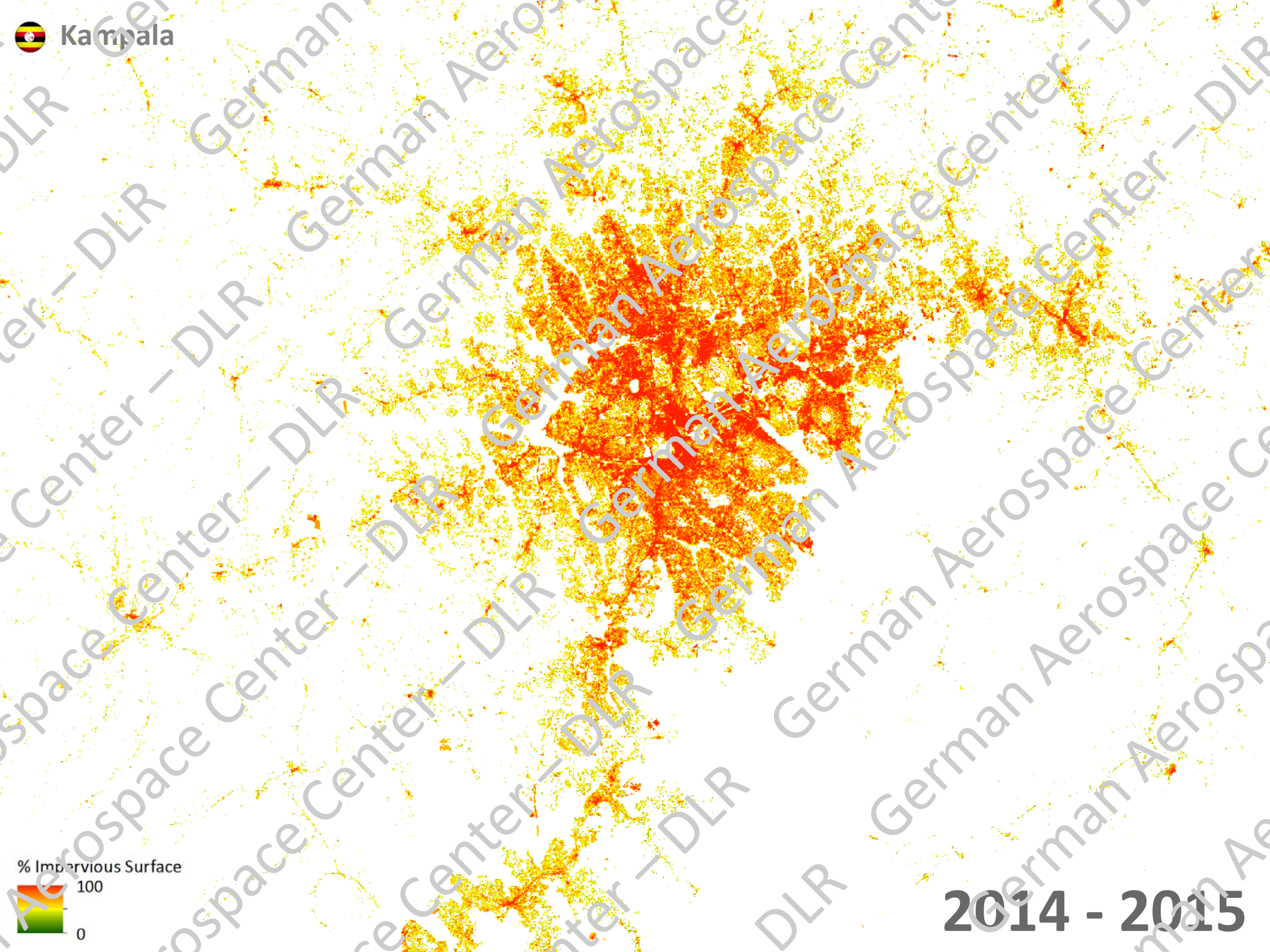

Pearl River Delta
German Aerospace Center – DLR
2014 - 2015


Pearl River Delta
2002-03
2014-15
German Aerospace Center – DLR

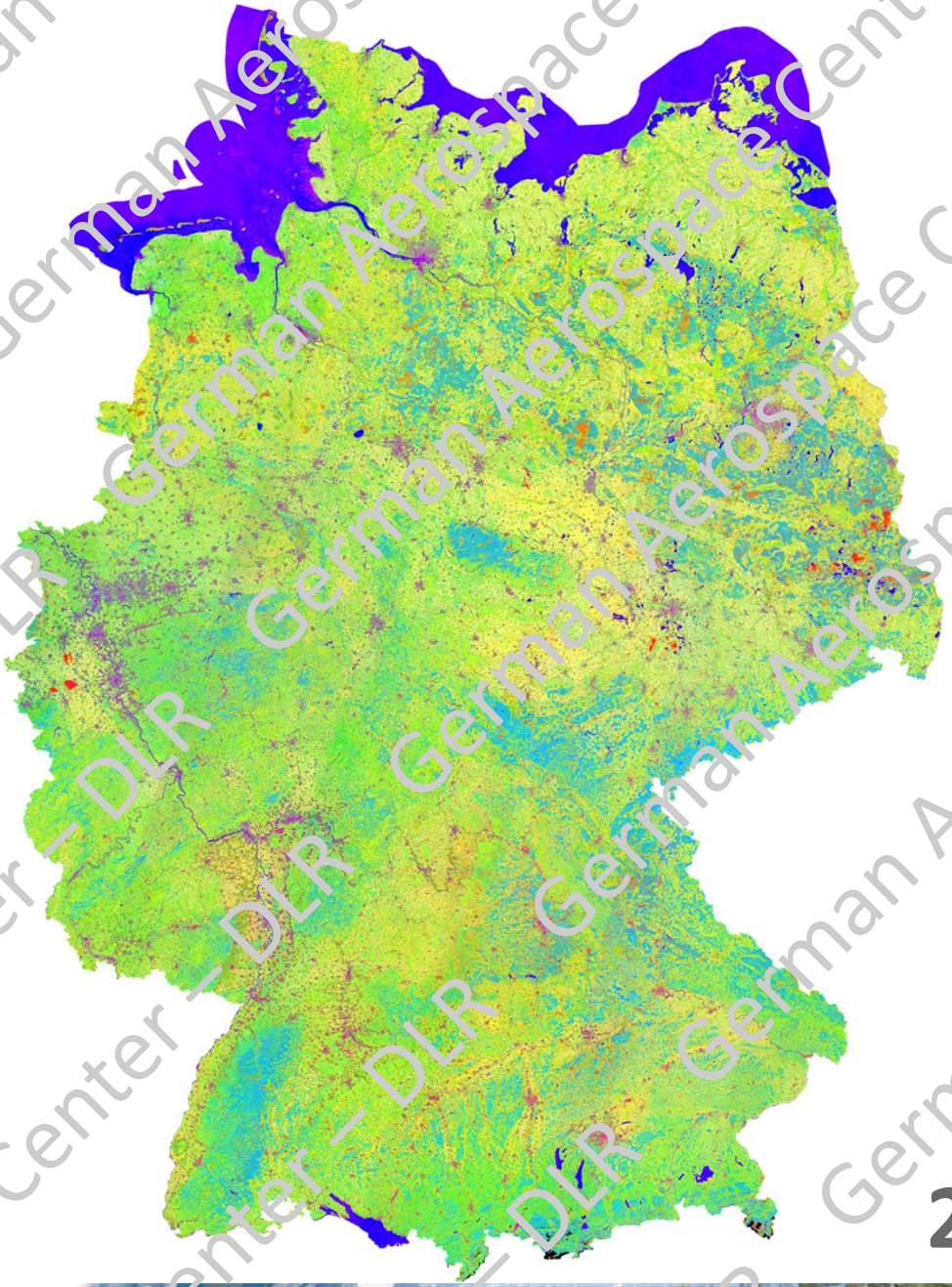

Addis Ababa
German Aerospace Center – DLR
2014 - 2015


Addis Ababa
% Impervious Surface
100
0
2014 - 2015


Kampala
German Aerospace Center – DLR
2014 - 2015

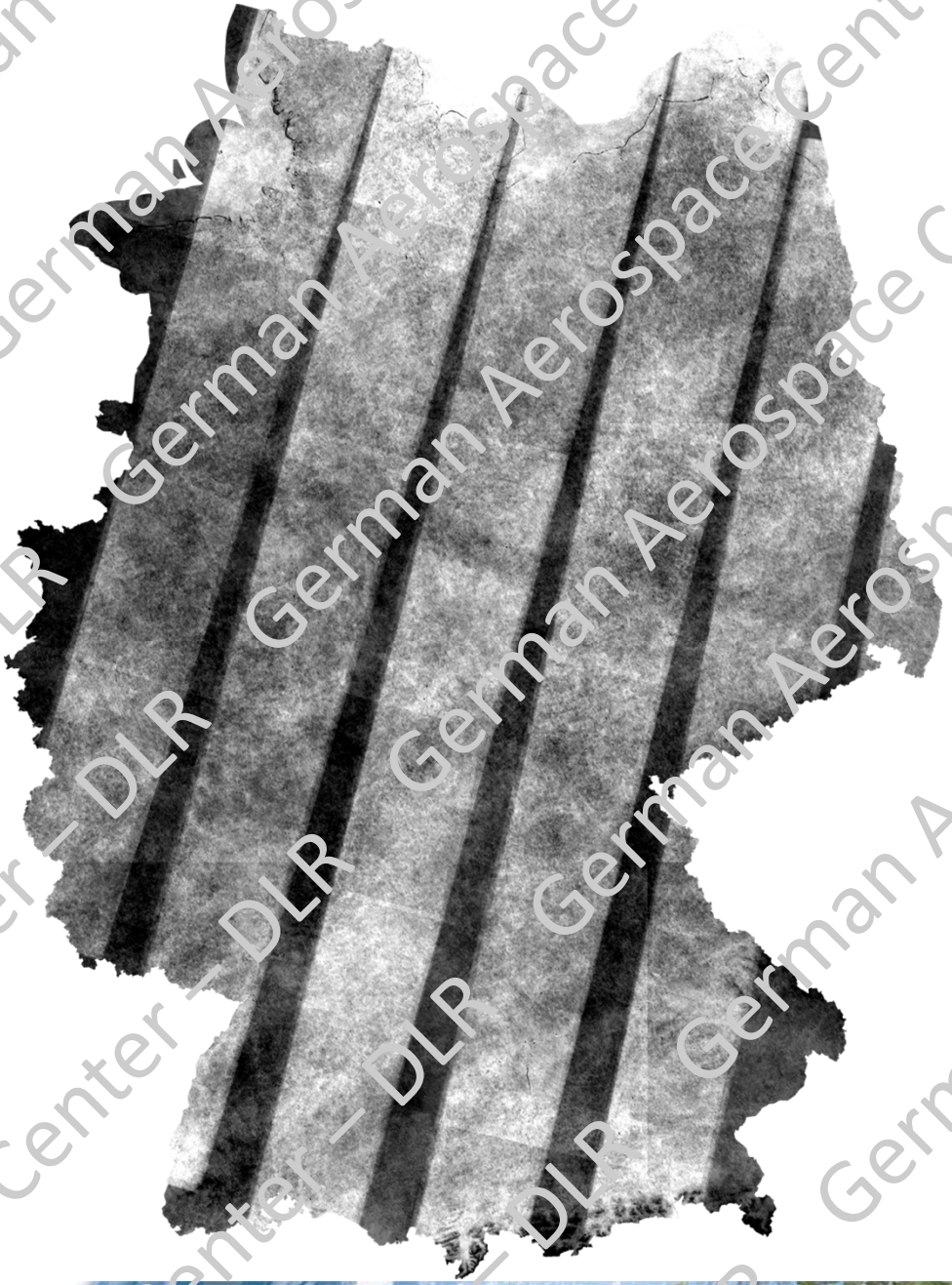

Kampala
% Impervious Surface
100
0
2014 - 2015
German Aerospace Center – DLR

Germany



2013 - 2015

Germany



n. available scenes

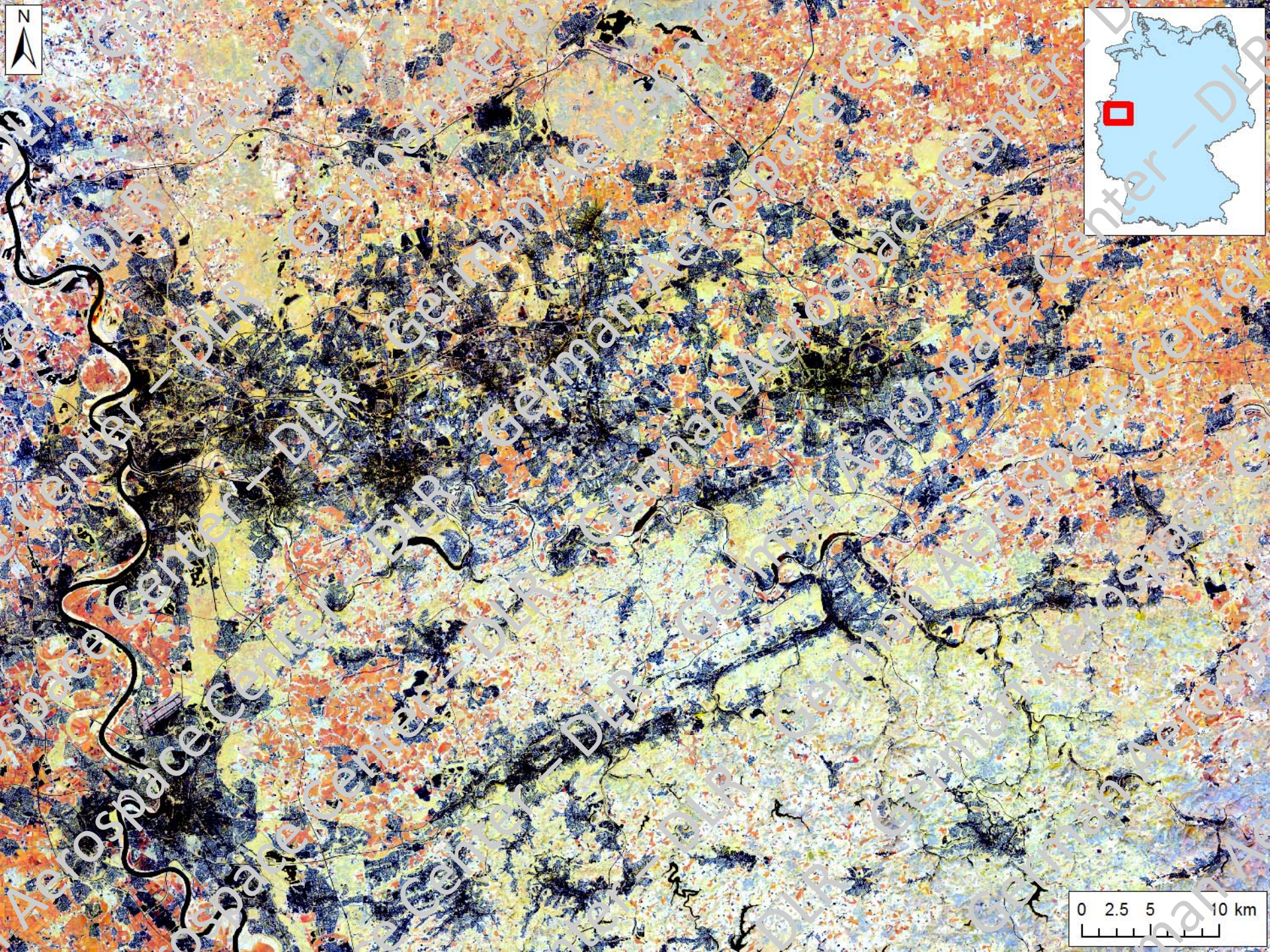
DLR

- Urban
- Cropland
- Grassland
- Broadleaved
- Coniferous
- Mixed Forest
- Bare Land
- Water
- Wetlands
- Permanent Crops
- Perennial Snow

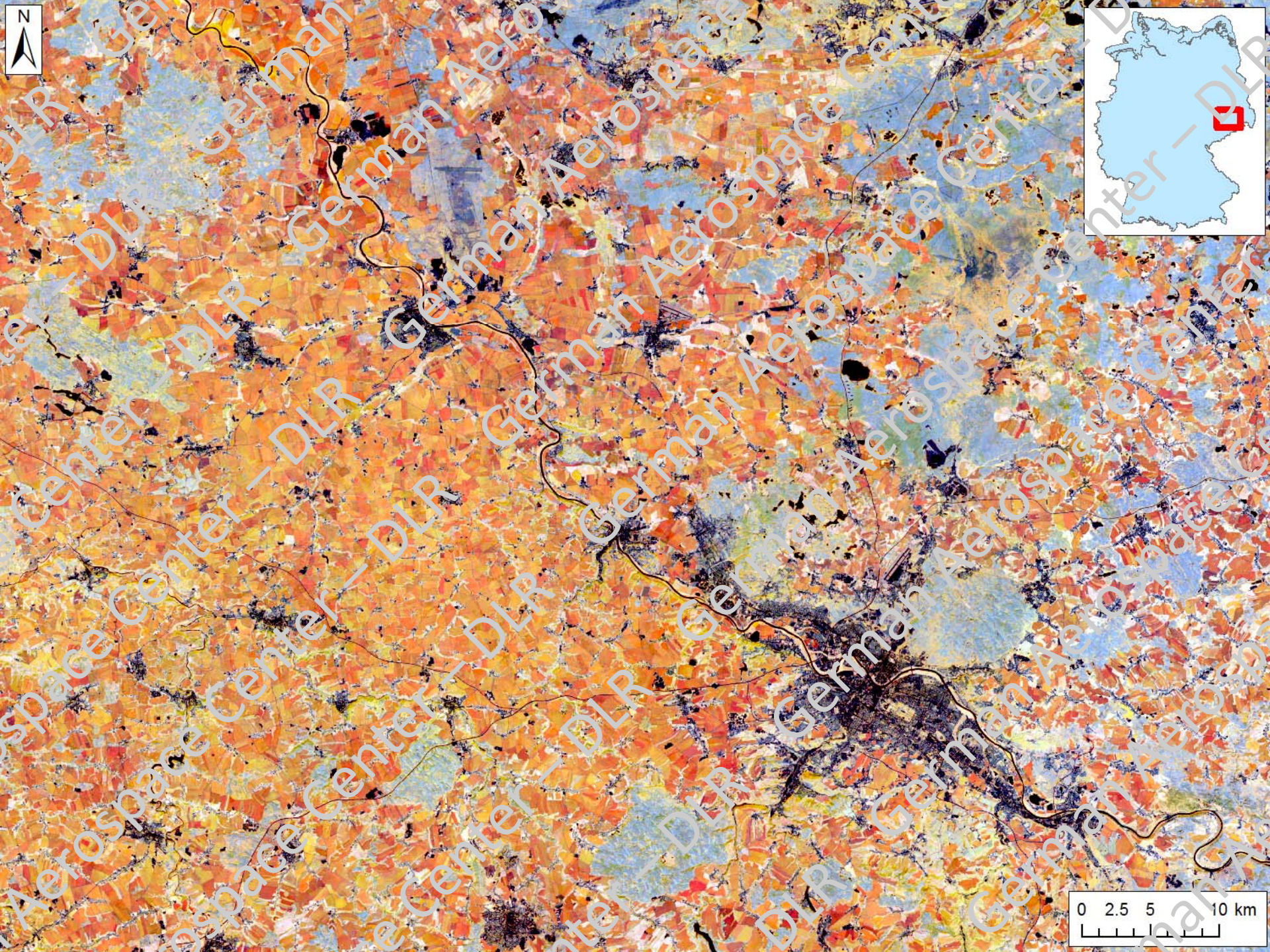
LUCAS points

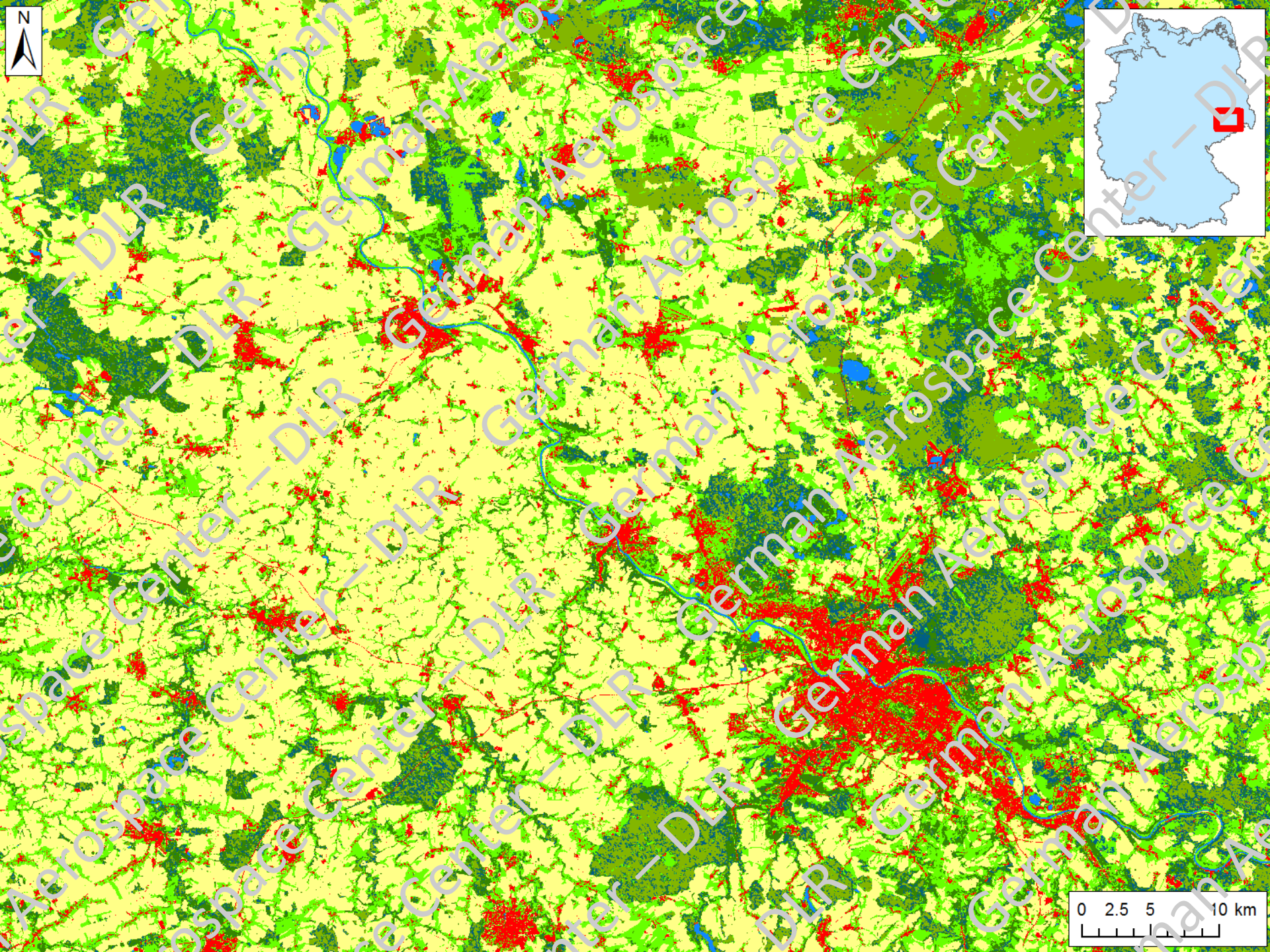
+ CORINE

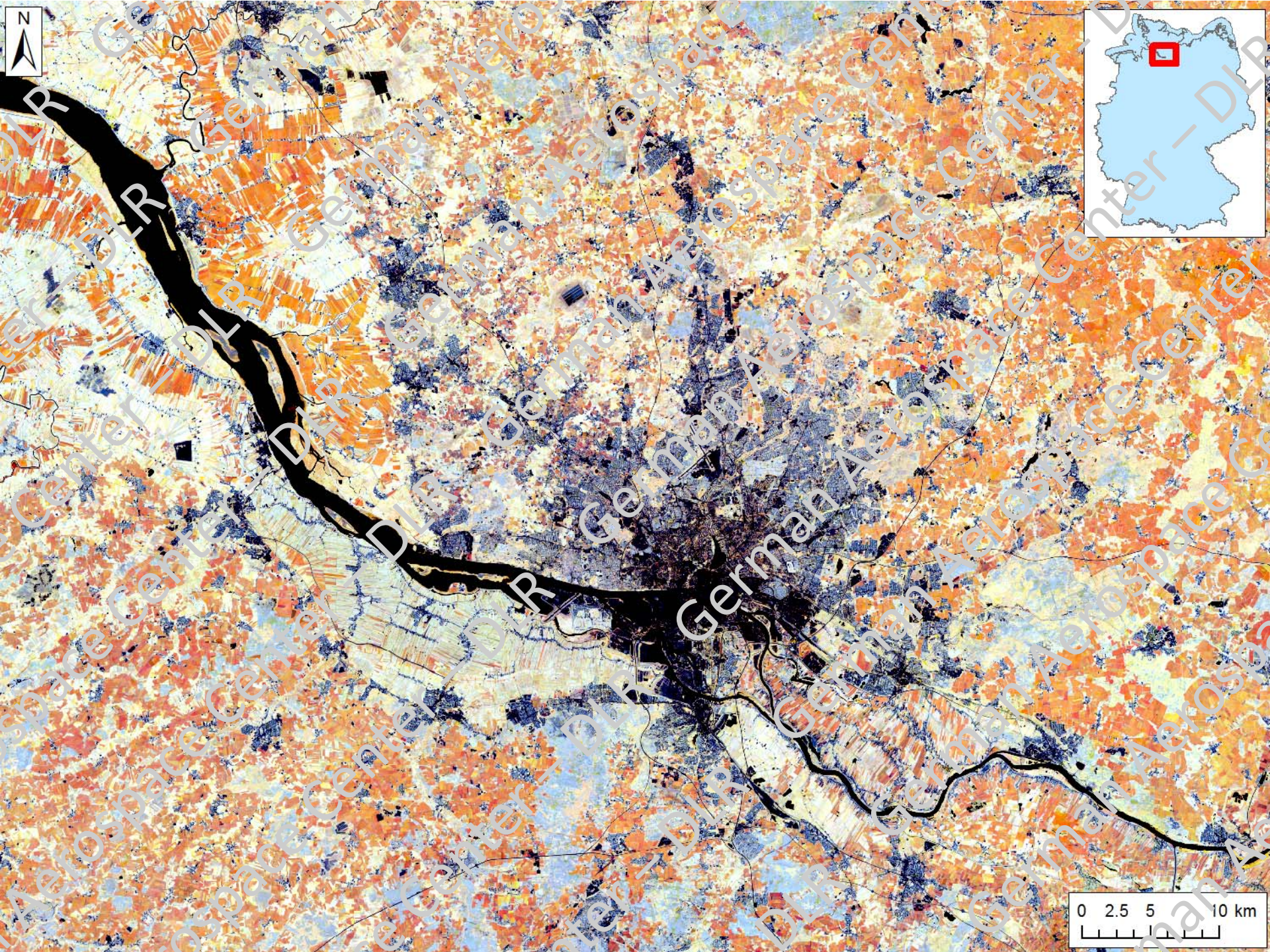
Fully-automatic SVM-based method

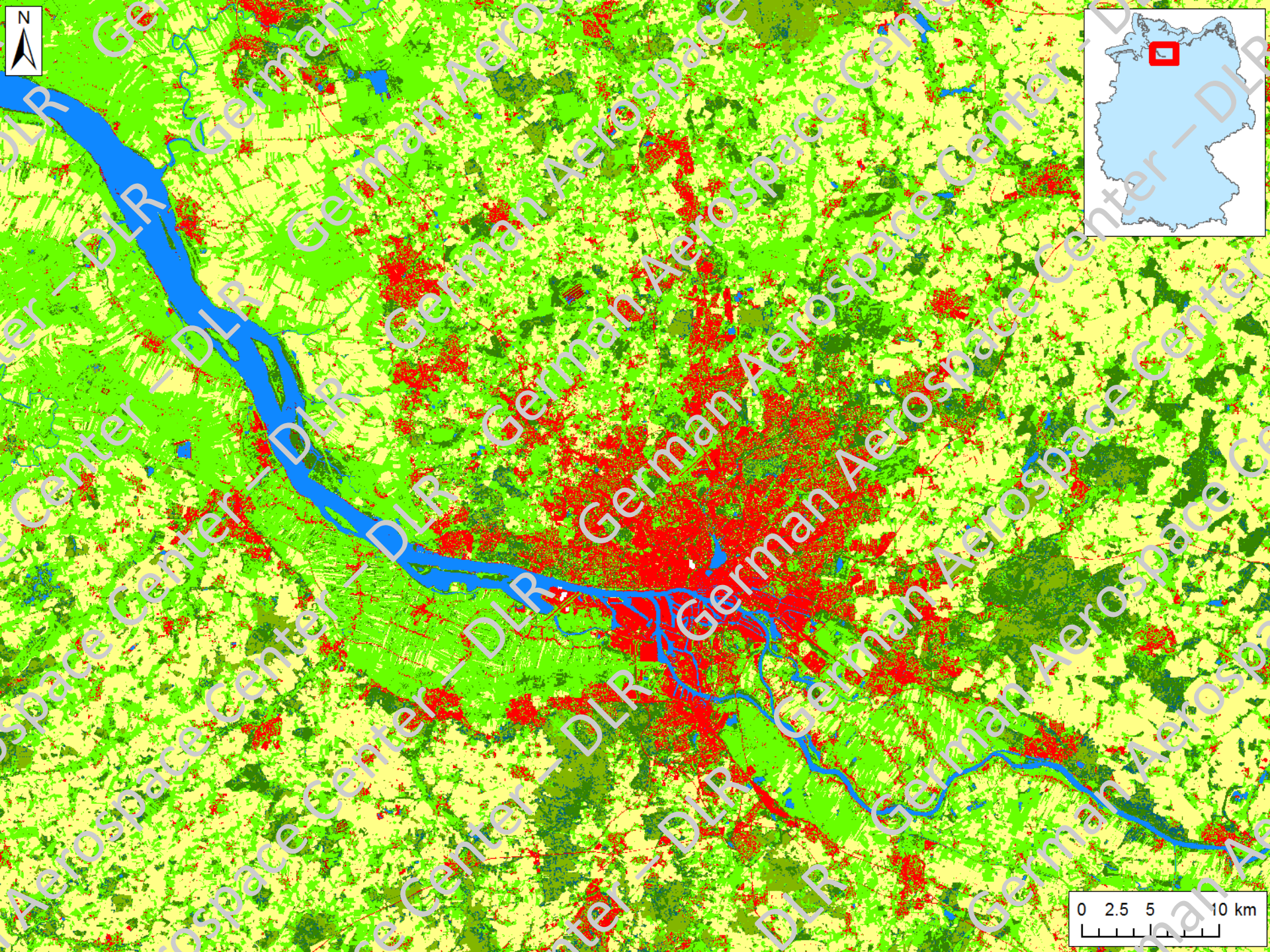

N
0 2.5 5 10 km

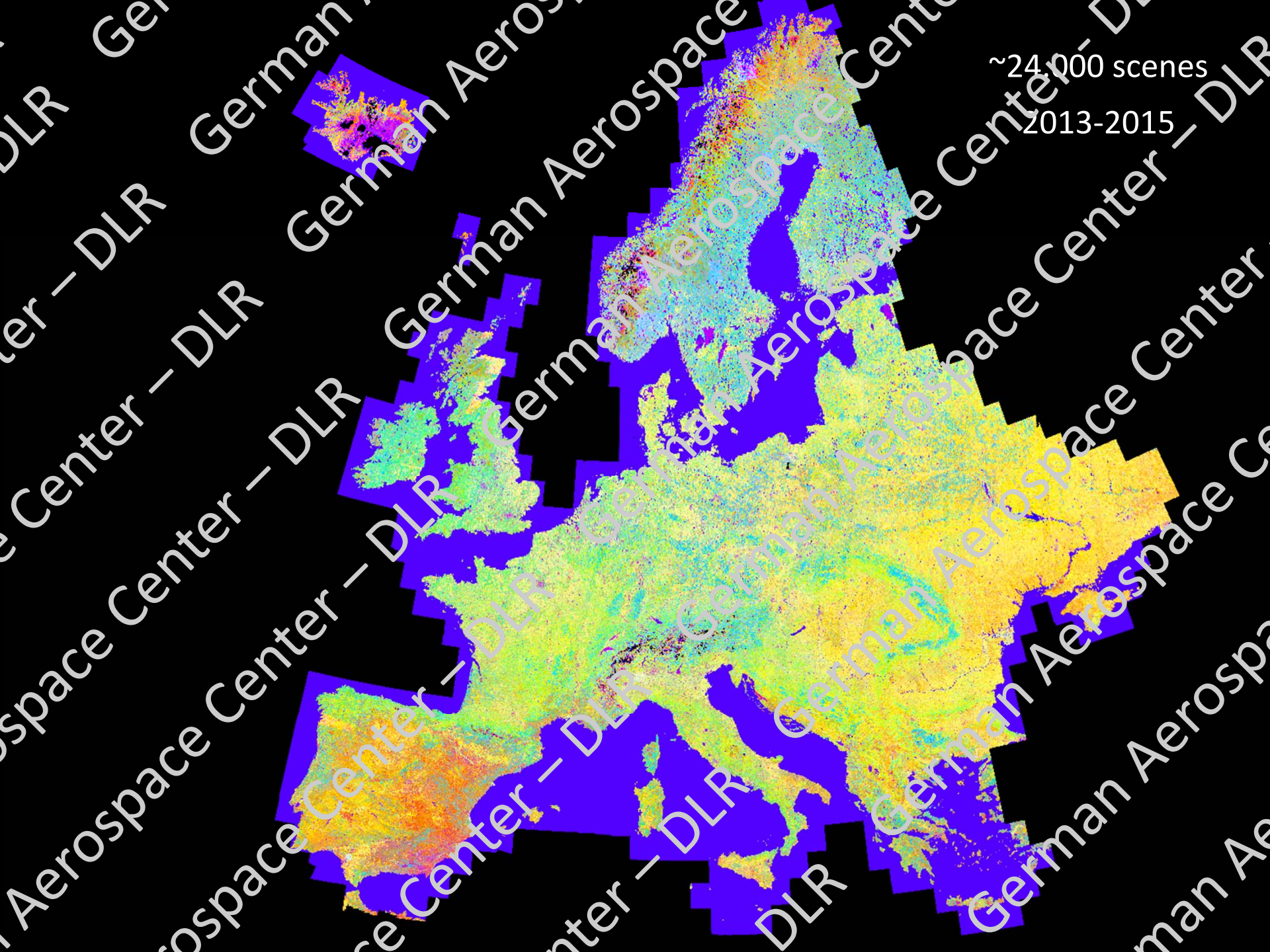

N
0 2.5 5 10 km


N
0 2.5 5 10 km


N
0 2.5 5 10 km
German Aerospace Center – DLR


N
0 2.5 5 10 km
German Aerospace Center – DLR


N
0 2.5 5 10 km


~24 000 scenes
2013-2015
German Aerospace Center – DLR


36.000 scenes
2013-2015

Conclusion

- Great potential for supporting a variety of applications;
- Already effectively applied to urban monitoring and land-cover problems with Landsat data;
- **The best has yet to come** – combining data from Landsat-8, Sentinel-2A and Sentinel-2B will offer unprecedented possibilities.

thanks a lot for your attention

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